Research Article

A comparative study of single-dose preoperative antibiotic prophylaxis versus routine long-term postoperative prophylaxis in elective general surgical cases

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Received June 28, 2015. Accepted September 28, 2015

Abstract

Background: Surgical site infection (SSI) is a major contributor to increased mortality and health-care cost globally, which can be reduced by appropriate antibiotic prophylactic use. The proper duration of antimicrobial use for the prevention of postoperative surgical infection has been a subject of controversy. No data currently exist about comparative study of single-dose preoperative antibiotic prophylaxis versus routine long-term postoperative prophylaxis in elective general surgical cases in India. We, therefore, examined risk factors, use, and efficacy of single-dose prophylactic antibiotic for SSI among patients in elective general surgical cases.

Objective: To study the effect of antimicrobial prophylaxis to know its effect on reducing postoperative wound infection.

Materials and Methods: This study is a randomized prospective and comparative study of a single-dose cefotaxime sodium Intra-Venous (I.V.) 1 g (40 mg/kg Body Weight (B.W.)) (versus long-term (5 days) postoperative in elective general surgical cases. A total of 200 patients were included in this study and were divided into Group A and Group B. Group A contains patients with 1 g of cefotaxime sodium intravenously, that is, single dose was given 1 h before induction of anesthesia and Group B contains patients who were given first dose at 1 h before induction of anesthesia, and subsequent doses were given at an interval of 12 h after surgery for 5 days, that is, multiple dose.

Result: The rate of wound infection in Group A was 10% and Group B was 9%. There was no statistical significance. *Staphylococcus aureus* was the most common organism causing wound infections.

Conclusion: In conclusion, single preoperative dose of cefotaxime sodium is cost-effective, and is as effective as multiple-dose prophylaxis, and a reliable method of prophylaxis in elective general surgical cases.

KEY WORDS: Antibiotic, preoperative, postoperative, single dose, wound infections

Access this article online	
Website: http://www.ijmsph.com	Quick Response Code:
DOI: 10.5455/ijmsph.2016.28062015153	

Introduction

Prophylaxis consists of the administration of an antimicrobial agent or agents before initiation of certain specific types of surgical procedures to reduce the number of microbes that enter the tissue or body cavity. Antimicrobial prophylaxis has been administered in many randomized clinical trials to reduce the incidence of postoperative wound infections

(WIs).[1–3] Currently, such prophylaxis is recommended at the time of many "clean-contaminated" and some clean operations.[4] In actual practice, however, we found that prophylactic antimicrobial agents are not often administered at the optimal time to ensure their presence in effective concentrations throughout the operative period.[5]

Infectious complications can be most unwelcome and difficult to control after major abdominal surgery, yet they are surprisingly frequent despite all modern prophylactic measures taken. Reported surgical WI rates in elective operations vary from 2% for inguinal hernia repair[6] to 26% for colectomy,[7] and even higher for emergency surgery.[8] Surgical site infections (SSIs) increase overall mortality and morbidity, and increase the length of hospital stay and overall costs. Prevention of SSIs begins with preoperative evaluation and identification of patients at high risk for SSI. Patient factors implicated in risk of SSIs include age, diabetes mellitus, smoking, steroid use, malnutrition, obesity, active distant infection, and prolonged hospital stay and nasal colonization with *Staphylococcus aureus*.[9,10] Inappropriate use of surgical antibiotic prophylaxis is common, for example, incorrect timing, duration, and use of oral antibiotics. The timing of first dose is very important, and improper timing is one of the most common problems in surgical prophylaxis. The agent selected should be the one to which the expected organisms are highly sensitive, and should have large volume of distribution, lower toxicity, and longer half-life, allowing single-dose administration. However, patient who undergoes complex, prolonged procedure in which the duration of the operation exceeds the serum drug half-life should receive an additional dose of antimicrobial agent.[11] There is no evidence that administration of postoperative doses of an antimicrobial agent provides additional benefit, and this practice should be discouraged, as it is costly and is associated with increased rates of microbial drug resistance. It is important to emphasize that surgical antibiotic prophylaxis is an adjunct to, not a substitute for, good surgical technique. Numerous clinical studies have clearly shown that appropriately timed "single shot" prophylaxis is as effective as multiple-dose prophylaxis. Keeping in view the value of prophylactic antibiotics in world literature, this study was undertaken to evaluate its place in our hospital to minimize great economic loss both in cost and staff-working hours, to the person as individual and the nation as a whole.

Materials and Methods

This study was conducted in the department of general surgery at Veer Surendra Sai Medical College, Burla, Sambalpur. This study is a randomized prospective and comparative study of single-dose cefotaxime sodium I.V. 1 g (40 mg/kg B.W.) versus long-term (5 days) postoperative in elective general surgical cases. All the patients were thoroughly examined and formal consent for inclusion in the study was taken. Inclusion and exclusion criteria were defined. A study includes all the patients who were electively operated for upper gastrointestinal, biliary tract, appendicitis, breast, thyroid, hydrocele, and hernia surgery between 18 to 70 years of age without any regard to sex. Patients with hypersensitivity or history of adverse drug reaction to cephalosporin group, renal impairment, liver disease, on steroid therapy, diabetes mellitus, and tuberculosis are excluded. A total of 200 patients were included in the study and divided in to Group A and Group B. Group A contains patients with 1 g of cefotaxime sodium intravenously, that is, single dose was given 1 h before induction of anesthesia and Group B contains patients who were given first dose at 1 h before induction of anesthesia, and subsequent doses were given at an interval of 12 h after surgery for 5 days, that is, multiple dose.

Follow-Up

All wounds were inspected before discharge, and all incisions were carefully examined during suture removal at 7 to 9 days (first follow-up visit) and during the second follow-up visit 4 to 6 weeks after discharge. Thereafter, all patients were followed up at 6-month intervals (third follow-up visit) until 1 year (fourth follow-up visit) after surgery.

Statistical Analysis

All analyses were performed with Statistical Package for Social Sciences version 16 statistical program. Chi-square test was used to examine the relationship between single-dose and multiple-dose antibiotic prophylaxis with other study variables, incidence of SSIs, sex, age, type of operation, and duration of operation.

Result

This study was conducted on 200 patients who were divided in to Group A and Group B. Table 1 describes different surgical procedure that have been done during the study period, out of which open cholecystectomy and hernioplasty constitute the major surgery in both groups. Table 2 shows incidence of WI in relation to age of patients. It is found that incidence of WI in Group A is 10% in comparison with Group B in which it is 9% and p-value is 0.809, which is more than 0.05 and hence, not statistically significant. Table 3 shows incidence of WI in relation to gender of patients. It is found that incidence of WI in male and female patients of Group A is 7% and 25%, respectively, which is statistically nonsignificant. Table 4 shows WI in patients with hemoglobin level between 10 and 12 g was 11.5% in Group A and 7.1% in Group B with $p = 0$, which is statistically significant. Tables 5, 6, and 7 show incidence of WI in relation to plasma protein, socioeconomic status, and duration of surgical procedure in between Group A and Group B, and it is found to be statistically insignificant.

Discussion

The highest incidence of infection was found to be in the age group of above 40 years (16%). The lowest infection rate was seen in the first decade. According to Shooter et al.

Table 1: The different surgical procedure during study period

Sr. no	Operative procedure performed	Group A		Group B	
		Cases	Per	Cases	Per
1	Open cholecystectomy	22	22.0	23	23.0
2	Hernioplasty	27	27.0	29	29.0
3	Herniorrhaphy	7	7.0	7	7.0
4	Thyroidectomy	7	7.0	7	7.0
5	Paraumbilical hernia repair	5	5.0	5	5.0
6	Epigastric hernia repair	3	3.0	2	2.0
7	Incisional hernia repair	6	6.0	6	6.0
8	Varicose vein surgery	4	4.0	3	3.0
9	Fibroadenoma excision	6	6.0	5	5.0
10	Circumcision	3	3.0	3	3.0
11	Varicocelectomy	3	3.0	3	3.0
12	Hydrocelectomy	7	7.0	7	7.0
	Total	100	100	100	100

Table 2: Incidence of WI in relation to age of patients

Age (years)	Group A			Group B			*p*
	N	WI	%	*N*	WI	%	
11–20	14	1	7.1	8	1	12.5	0.674
21–30	22	1	4.54	28	2	7.1	0.861
31–40	24	2	8.3	40	2	5.0	0.594
>40	40	6	15	24	4	16.6	0.795
Total	100	10	10.0	100	9	9.0	0.809

WI, wound infection.

Table 3: Incidence of WI in relation to gender

Sex	Group A			Group B			*p*
	N	WI	%	*N*	WI	%	
Male	84	6	7.1	80	5	6.25	0.819
Female	16	4	25.0	20	4	20.0	0.720
Total	100	10	10.0	100	9	9.0	0.809

WI, wound infection.

Table 4: Incidence of WI in relation to Hb% level

Hb level (gm/dl)	Group A			Group B			*p*
	N	WI	%	*N*	WI	%	
0–8	4	2	50.0	4	1	25.0	1.000
8–10	18	1	5.6	16	3	18.8	0.5101
10–12	52	6	11.5	56	4	7.1	0.0000
124 Move	26	1	3.8	24	1	4.2	0.5064
Total	100	10	10.0	100	9	9.0	1.000

Hb, hemoglobin; WI, wound infection.

(1960), the newborn patients and the older patients are highly susceptible to staphylococcal infection. According to Clark et al. (1974), the average age for higher infection rate was 42 years. Under identical situations, postoperative WI showed a rising tendency with the advance in age. As the probable cause is body defense mechanism that wanes out with the advancing age; hence, the age of the patients appear to exert a direct influence on WI rate. In this study, it is seen that the

Table 5: Incidence of WI in relation to plasma protein

Plasma protein (gm/dl)	Group A			Group B			*p*
	N	WI	%	*N*	WI	%	
5.5–6.4	56	6	10.7	40	5	12.5	0.9568
6.5–8.1	44	4	9.1	60	4	6.7	0.9315
Total	100	10	10.0	100	9	9.0	1.000

WI, wound infection.

Table 6: Incidence of WI in relation of socioeconomic status

	Group A			Group B			
Status	*N*	WI	%	*N*	WI	%	*p*
Low	30	6	20.0	30	4	13.3	0.7290
Middle	40	3	7.5	50	3	6.0	0.8873
High	30	1	3.3	20	2	10.0	0.7154
Total	100	10	10.0	100	9	9.0	1.000

WI, wound infection.

Table 7: Incidence of WI in relation to duration of surgical procedure

Duration in Hours	Group A			Group B			*p*
	N	WI	%	*N*	WI	%	
0–1	20	2	10.0	22	2	9.1	0.6701
1–2	64	4	6.3	58	3	5.2	0.8933
>2	16	4	25.0	20	4	20.0	0.9643
N	100	10	10.0	100	9	9.0	1.000

WI, wound infection.

incidence of WI is higher in the female population in both the groups (25% and 20%) in comparison with 6% and 6.25% in the male population. Clark et al. (1974) reported the incidence of WI higher in female patients, which corroborates well to the observation with this work. The probable factors that may be responsible for the higher rate are the more subcutaneous fat, anemia, and poor nutritional factors, which are often seen in female population of our country. It is observed from this study that the incidence of WI is more in patients with anemia. Similarly infection rate is higher in patients having plasma protein below the standard level [Table 5]. This is probably because of the suppression of host defense mechanism giving an upper hand to the pathogenic bacteria to multiply and invade. Wolf (1950) and Udupa (1969) reported higher incidence of WI in patients with anemia and hypoproteinemia. The higher incidence of WI in low socioeconomic status is probably because of their poor nutritional status and body defense mechanism. The incidence of WI is higher when the duration of operation is prolonged. In this study, it was 10% when the operation was finished within 1 h and 25% when the operation was prolonged for more than 1 h. Wasek et al. (1965) and Subremenium (1973) observed similar results. The explanation for this may be owing to greater exposure of the tissues to exogenous factors.

The success of the antibiotic prophylaxis is assured only when the chosen drug with a targeted spectrum is available at the critical moment, at the correct site, and in sufficiently high concentration, to prevent the bacterial contamination of surgical field. One cannot predict with certainty when bacterial contamination at the operation site may occur during surgery. Therefore, the selected agent should ideally cover the entire perioperative period of risk for postoperative infection, which may extend longer than the actual surgical procedure. It should also be remembered that the prophylactic antibiotics cannot compensate for correction of any coexisting medical problem or meticulous surgical technique. According to Scottish Intercollegiate Guidelines Network (SIGN)[12] (1) the antibiotics selected for prophylaxis must cover the expected pathogens for that operative site, (2) the choice of antibiotic should be taken into account with its local resistance patterns, (3) narrow spectrum, less expensive antibiotics should be the first choice for prophylaxis during surgery, (4) prophylactic antibiotics for surgical procedures should be administered intravenously, and should be given within 60 min before the skin is incised and as close to time of incision as practically possible, (5) a single dose of antibiotics with a long half-life to achieve activity throughout the operation is recommended, (6) an additional intraoperative dosage of antibiotic is recommended for surgery longer than 4 h, and (7) in the event of major intraoperative blood loss in an adult patient (>1,500 mL), additional dosage of prophylactic antibiotic should be considered after fluid replacement. There are many other risk factors apart from antibiotic prophylaxis, which should be taken in to consideration by every surgeon seriously. They are patient-related factors such as antiseptic baths, that is, preoperative bath/showers reduce the microbial load of the skin, and clipping hair immediately before an operation has been associated with decreased rates of SSIs and is a recommended practice. There are factors that are directly related with surgical team, that is, team members coming directly in contact with the sterile-operating field, sterile instruments, or supplies used must perform a surgical scrub for at least 2 to 5 min with broad-spectrum antiseptic agent that is fast acting and having a persistent effect. This may be 4% chlorhexidine gluconate or 7.5% chlorhexidine gluconate having greater residual antimicrobial activity. The studies by Burke and a recent follow-up study have shown that postoperative antibiotics were much less useful in reducing infection than those given before surgery.[13,14] The American Society of Health System Pharmacist recommends prophylaxis with cephalosporin for elective surgical cases.[15]

Conclusion

Surgical WIs are common and consume a considerable portion of health-care finances. Although surgical WIs 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 preexisting medical illness, prolonged operating time, the wound class, and wound contamination strongly predispose to WI. The judicious use of antibiotic prophylaxis and the use of an organized system of wound surveillance and reporting are the most effective means to reduce the WI rate to an attainable minimum. In conclusion, single preoperative dose of cefotaxime sodium is cost-effective and is as effective as multiple-dose prophylaxis and is a reliable method of prophylaxis in elective general surgical cases.

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How to cite this article: Ranjan A, Singh R, Naik PC. A comparative study of single-dose preoperative antibiotic prophylaxis versus routine long-term postoperative prophylaxis in elective general surgical cases. Int J Med Sci Public Health 2016;5:1083-1087

Source of Support: Nil, **Conflict of Interest:** None declared.