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To study the planned surgical procedure in single-dose antibiotic prophylaxis

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ABSTRACT

Background: Postoperative wound infection may be due to many causes, of which "microbial contamination" is the factor that is influenced by antibiotic administration. Since the concept of antimicrobial prophylaxis has emerged, several workers have searched for optimal antimicrobial drugs, their routes, and the timing of their administration, with the ultimate goal of achieving zero sepsis. The use of preoperative systemic antibiotics has brought down the incidence of wound infection considerably. **Aims and Objectives:** The aim is to identify which drug is the best option for single-dose antibiotic prophylaxis to prevent postoperative wound infection. **Materials and Methods:** This is a prospective study. The study was conducted in the surgical ward of J.A. Group of Hospitals, Gwalior, Madhya Pradesh, India, from May 2020 to April 2022. Patients of all sexes and ages were included in the study. Patients were divided into five groups according to a class of antibiotics. The study consisted of a total of 125 patients admitted to the surgical ward. Statistical Package for the Social Sciences–(10 systems) was applied for the study. P<0.05 was considered statistically significant. **Results:** A total of 125 patients were studied in five groups, depending on the antibiotics. The A, B, C, and D groups were given only a single dose of antibiotics, while group E was given a full course of antibiotics during preoperative, intraoperative, and postoperative periods. Out of 125 cases, only 5 patients had clinical and bacteriological evidence of wound sepsis in different groups of single-dose antibiotics, and one case in group E had multiple doses of antibiotic given. The wound infection rate in clean patients was 20% in ceftazidine, 12.5% with piperacillin tazobactum and cefoperazone sulbactum, and 21.1% in the multiple dose group. No infection was reported with amoxycillin-clavulanic acid. *Staphylococcus*, *Escherichia Coli,* and *Klebsiella* were the offending agents, and anaerobic infections were not found. **Conclusion:** A single dose of antibiotic prevents the suppression of normal, sensitive microbial flora, which is usually seen with multiple doses of antibiotics. In this way, it helps in keeping the patients infection-free without interfering with their naturally inherited immunological status of the patient.

Key words: Antibiotic prophylaxis; Cefoparazone; Ceftizidime; Piperacillin

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INTRODUCTION

Many serious and time-consuming operations performed with great skill and labor get spoiled in a minute by a tiny microbe—the most common being *Staphylococcus*. The various neurosurgical, cardiothoracic, and plastic surgeries, whose expertise has already sucked nearly half of a surgeon's carrier, are cast into tears of pus in the wound by these selfish microbes. How depressing it is to look at the patient feeling ill and lethargic even 7 days after the operation, making him or her weaker day by day, both by lowering his or her resistance to microbes and by causing a weeping pocket caused by prolonged use of prophylactic antibiotics.

Postoperative wound infection may result from many causes, out of that "microbial contamination" is the factor that is influenced by antibiotic administration.

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Since the concept of antimicrobial prophylaxis has emerged, several workers have searched for the optimal antimicrobial drug, its route, and timing of administration, with the ultimate goal of achieving zero sepsis.

In the very early phase, the antibiotics were only administered postoperatively for the treatment of an already established surgical wound infection. Later on, the concept of antibiotic prophylaxis was introduced. Initially, the antibiotics were administered postoperatively for a prolonged period without any significant reduction in the surgical wound infection rates. It was subsequently discovered that antibiotics need to be administered preoperatively for prophylaxis of wound infection. The use of preoperative systemic antibiotics has brought down the incidence of wound infection considerably.

By giving a single dose of antibiotic immediately before the operation and keeping its blood level arise only until the patient is back in bed and conscious, the well-known disadvantages of prolonged antibiotic prophylaxis could be avoided since there would not be any time to suppress the normal bacteria.

Aims and objectives

- To assess the efficacy of a single-dose antibiotic in comparison with multiple doses of antibiotics given as antimicrobial prophylaxis in the prevention of post-operative wound infection
- To identify which drug is the best option for single-dose antibiotic prophylaxis to prevent postoperative wound infection
- To prevent the suppression of normal, sensitive microbial flora seen with multiple doses of antibiotics
- To reduce the patient's expenditure due to prolonged antibiotic use without affecting the final results of the operation.

MATERIALS AND METHODS

The present prospective study consists of a total of 125 patients admitted to surgical wards of J. A. Group of Hospitals, Gwalior, between May 2020 and April 2022. All patients underwent elective surgeries, which lasted for <3 h.

Inclusion criteria

- Patients of all sexes and ages were included in the study.

Exclusion criteria

- Patients with a history of allergy to any of the antibiotics were excluded from the study. Patients with infections at other sites were also excluded
- Patients who had received antibiotics within the previous 7 days before the operation were excluded from the study except for group E
- Patients who had an existing indication for antibiotic prophylaxis (i.e., valvular heart disease) and known renal or liver impairment (potentially immunocompromised patients) were excluded from the study
- All patients who were investigated for anemia, tuberculosis, diabetes mellitus, cardiovascular disease, and high serum creatinine (more than 2 mg/dL) were excluded from the study
- All patients were given antibiotics intravenously at the time of induction of anesthesia except group E, in which a full course of preoperative, intraoperative, and postoperative antibiotics was given
- Patients were randomized into five groups according to the antibiotics.

Group A: Ceftazidime

Group B: Piperacilline tazobactum

Group C: Amoxycillin and clavulanic acid

Group D: Cefoparazone sulbactum

Group E: full course of antibiotics.

Antibiotic selection

The following points were kept in mind while choosing these drugs:

1. A broad-spectrum antibiotic agent that covers the spectrum of microorganisms usually involved in the specific type of operation
2. Fewer side effects
3. Easy availability
4. Cost-effectiveness.

Ceftazidime

Ceftazidime is a bactericidal third-generation cephalosporin antibiotic.

Piperacillin tazobactam

It is an injectable antibacterial combination product consisting of the semisynthetic penicillin antibiotic piperacillin and the beta-lactamase inhibitor tazobactum for intravenous administration.

Cefoparazone-sulbactum

Cefoparazone is a third-generation cefolosporin.

Pre-operative methods

1. Shaving was done 24 h prior to surgery
2. The patient was shifted to the operation theater after applying a sterile bandage over the proposed part of surgery. Patients were given clean gowns to wear and then enter inside the operation theater

3. In the operation theater, skin preparation was done with Savlon scrub, followed by povidone, iodine, and spirit.

Intra-operative methods

A single dose of the planned antibiotic was administered intravenously at the time of the induction of anesthesia.

Post-operative follow-up

1. The wound was examined after taking aseptic precautions. This was done on the 2nd, 3rd, 4th, and 6th days of operation
2. After the 7th postoperative day, stitches were removed and the patient was discharged. The patient was followed again in the 2nd week in the outpatient department.

RESULTS

In the present study, a total of 125 patients who underwent planned surgery in the surgical wards of J.A. Group of Hospitals and G.R. Medical College, Gwalior (M.P.) between May 2020 and April 2022 were included.

This study was carried out in five groups:

Group A - Patients who received Ceftazidime
Group B - Patients who received Pipracilline Tazobactum
Group C - Patients who received amoxicillin and clavulanic acid
Group D - Patients who received cefoparazone sulbactum
Group E - Patients who received a full course of antibiotics

- Each group consisted of 25 patients
- Each antibiotic was administered at the time of the induction of anesthesia
- Only planned surgical procedures were included in this study
- In all five groups, postoperative evaluation of the wound was done, and any discharge from the wound was sent for bacteriological culture and sensitivity testing.

Table 1 shows that no infected patients were reported between the ages of <1 and 30 in all 5 groups. Between 31 and 40, single patients reported infection in group D; between 41 and 50, a single patient was infected in group B; 51–60, one infection in Group A; and 61–70 years, a single patient showed infection in groups A, D, and E. 71–80, none of the patients show infectivity.

When the Chi-square test is applied for rate of infection in the 61–70 age group for all five groups, the Chi-square test value is 3.01 and P=0.55 (difference is significant when P<0.05), which shows that there is no significant difference in rate of infection in all groups and they are comparable.

The total number of patients is 125, with 15 males and 10 females in each of the 5 groups. Among all cases, six were found to be infected, including four females (groups A, B, D, and E) and two males (groups A and D) (Table 2).

At the completion of each operative procedure, the time of the operation in minutes was recorded.

Table 3a shows that the maximum infection rate is seen in group A when the operative time is >120 min, followed by equal 4 cases in groups A, B, and E when the operative time is 91–120 min, and minimum 2 cases in group C when operative time is 61–90 min, while no infection is seen in any of the groups when operative time is <60 min. As the duration of the operation increased, a progressive rise in the infection rate was observed. It was also found that the majority of severe infections were associated with prolonged surgery.

Table 3b shows no infection was reported when operative time was <60 min. The rate of infection among the operative durations between 61 and 120 min was as follows: 1 case in group A, 1 case in group B, 2 cases in group D, 1 case in group E, and no wound infection reported in group C when the Chi-square test was applied (P=0.73), which means no significant difference was there in any of the groups, either single or multiple doses of antibiotic were used. The rate of infection increased with the operative time, as proven with wound infection rate in group A (50%) when the operative time was >120 min.

This study shows that the overall wound infection rate is maximum in group A and D (4 cases), followed by group B and E (2 cases), and no wound infection is seen in group C. When the Chi-square test was applied, all groups were comparable, and no significant difference was observed (χ^2=2.45, P=0.6) (Table 4).

DISCUSSION

The purpose of the present study was to examine the influence of a single antimicrobial agent on the incidence of wound sepsis in patients undergoing elective surgical procedures. Whether a single dose of prophylactic antibiotic is good enough to take care of the patients while at the same time patient does not shows any local or systemic signs of infection. In this way, it is obvious that the total expenditure borne by the hospital or the patient can also be significantly lowered by reducing the antibiotic load.

Table 1: Age distribution of cases

Age of pt. (years)	Group A		Group B		Group C		Group D		Group E	
	No. of pt. (n=25)	Pt. infected	No. of pt.(n=25)	Pt. infected	No. of pt. (n=25)	Pt. infected	No. of pt.(n=25)	Pt. infected	No. of pt. (n=25)	Pt. infected
<1	1	-	0	-	0	-	0	-	0	-
1–10	1	-	1	-	2	-	0	-	1	-
11–20	5	-	4	-	3	-	1	-	3	-
21–30	7	-	6	-	5	-	7	-	6	-
31–40	3	-	6	-	4	-	10	1	2	-
41–50	1	-	3	1	5	-	1	-	3	-
51–60	4	1	3	-	1	-	4	-	4	-
61–70	3	1	2	-	4	-	2	1	4	1
71–80	0	-	0	-	1	-	0	-	2	-

Table 2: Sex distribution of cases

Group	Males		Females	
	Total no. of patient	No. patient infected	Total	No. patient infected
A (n=25)	15	1	10	1
B (n=25)	15	0	10	1
C (n=25)	15	0	10	0
D (n=25)	15	1	10	1
E (n=25)	15	0	10	1

A wide range of different age groups of patients were studied in this trial. The wound infection rate increased steadily in patients older than 30 years. Similar findings were observed by the public health laboratory service in 1995 and the committee on trauma in 1999.[1] In the present study, the postoperative wound infection rate was seen more in elderly patients, like in 61–70 years of age in both study groups. The higher rate of infection among older patients may be due to poor health and general debility, the carrier state of multiresistant microorganism, and reduced immunological efficiency at extremes of age, as described by Dineen in 2004. Patients more than 66 years of age are 6 times more likely to develop infection than are patients 1–14 years of age. In a study of 468 clean wounds, we found an infection rate of 3.4% in patients <65 years and 2.7% in >65 years. Even in cleanly contaminated procedures, age has been associated with an increased infection rate, as reported by Cruse in a relatively homogeneous population of patients undergoing elective colorectal procedures.[2]

Out of 125 cases, 75 were males and the rest was females. The overall infection rate in females in the present study was much higher than that of males, but there was an equal incidence (10%) of wound infection in females in groups in which a single antibiotic was given to groups in which a full course of antibiotics was given, which shows that there is not much difference in wound infection rates when a single antibiotic is given in place of multiple doses in respective of the sex.

An association was observed between the infection rate and the duration of the operation. The incidence of postoperative wound infection increased with an increase in the duration of the operation. Similar results were reported by Subramanian et al. According to these studies, the infection rate percentages in <60 min are 6.3% and 0.9%, respectively, and in the present study, it is 0% in all five groups, while in 61–120 min the infection rates are 13.7% and 4.2%, respectively, and in the present study it is between 7.1% and 20% in different groups, but in >120 min the infection rates are 40.7% and 50.6%, respectively, and in the present study it is 50% in group A.

The rate of infection of a clean wound increases significantly with an increase in the duration of operation in both groups, either with single or multiple dose antibiotics, without any significant difference in infection rates in all groups (P=0.83). The rate of infection in clean wounds roughly doubles with every hour (Miles AA, 2001). The association between the two may be the result of increased bacterial contamination with time, increased damage to wound cells due to long exposure, increased exposure to the theater atmosphere, and an increased amount of suture and electrocoagulation reducing the local resistance of the wound. To this may be added the increased manipulation and systemic insult to the patient through blood loss (2001).[3]

The infection rates in clean wounds as reported by Cruse in different studies conducted were 1.8% and 5%, respectively. In the present study, a 5.1% infection rate was reported in group D; no infection was reported in other groups.

The declining incidence of post-operative wound infection rate in Indian settings, particularly in the last decade, is probably due to increased awareness of aseptic and antiseptic precautions. The dreaded diseases like AIDS and hepatitis B have made every surgeon to be over cautions, starting right from entering the operation theater and then finally leaving the theater after the operation. It is needless to stress that this encompasses the washing of hands and the wearing of sterile gowns and gloves, which all form important keys to keeping the patient

Table 3a: Operative time and incidence of wound infection

Duration (min)	Group A		Group B		Group C		Group D		Group E	
	Total no. of pt.	Pt.infected	Total no. of pt.	Pt. infected	Total no. of pt.	Pt. infected	Total no. of pt.	Pt. infected	Total no. of pt.	Pt. infected
0–30	5	0	7	0	3	0	5	0	3	0
31–60	10	0	9	0	15	0	9	0	7	0
61–90	4	0	5	0	5	0	10	2	10	0
91–120	4	1	4	1	2	0	0	0	4	1
>120	2	1	0	0	0	0	1	0	1	0

Table 3b: Operative time and incidence of wound infection

Duration (min)	Group A		Group B		Group C		Group D		Group E	
	Total no. of pt.	Pt. infected	Total no. of pt.	Pt. infected	Total no. of pt.	Pt. infected	Total no. of pt.	Pt. infected	Total no. of pt.	Pt. infected
0–60	15	0	16	0	18	0	14	0	10	0
61–120	8	1	9	1	7	0	10	2	14	1
>120	2	1	0	0	0	0	1	0	1	0

Table 4: Overall wound infection rate

Group	Total no. of patients	Patient infected	%
A	25	2	8
B	25	1	4
C	25	-	-
D	25	2	8
E	25	1	4

infection-free. The newer techniques of article sterilization (autoclaving, gamma radiation, etc.), improved theater care, and cleanliness have all led to an increase in the operation theatre standard in the past few years.

The postoperative wound infection rate in clean surgeries in the present study is between 11.1% and 20% in different groups, with no wound infection reported in group C (P=0.7).

Shaving done immediately before the operation prevents bacterial growth in the razor nick. This study shows that shaving done 24 h prior to operation significantly increases the risk of postoperative wound infection as compared to shaving done just 1 h before operation, but no significant difference was observed in infection rate when single-dose antibiotics or multiple doses of antibiotics were given and shaving done before 24 h of surgery (P=0.9) or shaving done 1 h before surgery (P=0.5). The explanation for this is that when shaving is done 24 h before operation, there is an increase in the proliferation of microorganisms at the site of razor nicks, which further leads to operative wound contamination resulting in wound sepsis.

The prophylaxis of primary wound sepsis depends principally on taking measures to minimize exogenous and endogenous wound contamination and the use of potent antibiotics parenterally. The avoidance of secondary sepsis is a different matter related to hospital cross-infection (1997).[4]

Griffith in 2006[5] reported frequent infection by coliform infection following preoperative single intravenous use of Tobramycin and Lincomycin reported dominance of Staphylococci in clean wounds and intestinal organisms in contaminated wounds 2006[6] and reports of the public health laboratory service in 1960 quoted a very high figure of staphylococci isolation, i.e., 50% and 45%, respectively. In 1996,[7] oagulase-positive staphylococci were reported in 35% of wounds. In 2001,[8] we reported 29% of the incidence of staphylococci wound infection. In the present study, *Staphylococcus aureus* was the most common organism isolated from the cultures of infected post-operative wounds, followed by *Escherichia coli* from the wound cultures of the patients. Anaerobic organisms were not isolated from any of the postoperative infected wounds in the present study.

The chief place of infection of surgical wounds due to staphylococci is the operation theater, as shown by studies of many workers. The surgeons, nurses, OT boys, and students may be the nasal carriers. It has been reported by many workers that there is now a shift in the pattern of hospital-acquired infections from Staphylococci to gram-negative organisms in 1998,[10] showed increased isolation of gram-negative organisms from wounds where operations were performed on the gastrointestinal tract. Similar results were all reported in 2004.[11] The results are comparable to those of various studies that have indicated a relationship between nasal carriage of *S. aureus* and subsequent post-operative infection. *Staphylococcus* reported from the skin is the major pathogen responsible for post-operative infection. Patients own skin flora is a major source of wound infection.

The current study did not demonstrate a difference in the rate of infection between patients receiving preoperative antibiotics alone (5%) versus those receiving preoperative followed by postoperative multiple dose antibiotics (4%, P=0.8). The P=0.8 confirms the validity of this study. The findings in this study coincide well with the experimental animal studies and other clinical studies regarding the use of prophylactic antibiotics. Overall, 6 (4.8%) patients developed infectious complications, five from the antibiotic prophylaxis group in which a single antibiotic was given and 1 from group E (P=0.6) in which multiple doses of antibiotic were given. All these patients were treated conservatively, i.e., antibiotic treatment in all cases plus wound opening and delayed primary closure in one case.

Limitations of the study

Less sample size due to Covid 19 pandemic.

CONCLUSION

- Only a single dose of antibiotic administered at the time of induction of anesthesia is able to prevent post-operative wound infection as efficiently as multiple doses of antibiotic prophylaxis
- A higher drug concentration achieved at the time of wound closure in this manner is perhaps the best option for administering prophylactic antibiotics
- A single dose of antibiotic prevents the suppression of normal, sensitive microbial flora, which is usually seen with multiple doses of antibiotics use. In this way, it helps in keeping the patient infection-free without interfering with their naturally inherited immunological status of the patient
- Amoxicillin clavulanic acid is perhaps the best option in preventing post-operative wound infection among the single dose antibiotics
- A single dose of antibiotic administered prophylactically did not lead to any sign of systemic infection, which is usually the case due to immunological suppression following prolonged use of antibiotics
- A single of antibiotic as antimicrobial prophylaxis in planned surgical procedures also reduces the patient's as well as the hospital's expenditure significantly.

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