

# Clinical Study on Single Dose Antibiotic Prophylaxis in Planned Surgical Procedures

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## Abstract

**Background and Objectives:** The prevention of surgical site infection (SSI) remains a focus of attention because wound infections continue to be a major source of expense, morbidity, and even mortality.

**Materials and Methods:** A prospective study was carried out on 100 patients from 12 to 60 years age group, of both sexes, coming to the department of surgery during the period of November 2017 to April 2019 and getting admitted.

**Results:** In this study, Protocol 1 showed 8% infection rates whereas Protocol 2 showed 12% infection rates. Out of 50 cases of Protocol 1, 25 cases received antibiotic prophylaxis half-an-hour before incision accounting for 1 (4%) infected case and 25 cases received antibiotic prophylaxis 1 h before incision accounting for 3 (12%) infected cases.

**Conclusion:** In our study, we have seen the importance of timing of the dose to be administered and that following closure, the administration of the antibiotics is not very effective and not necessary. Single dose of 1 g inj. ceftriaxone intravenous given half an hour before incision is sufficient to prevent SSIs, provided extra dose has to be given if the surgery has passed more than 3 h.

**Key words:** Antibiotic prophylaxis, Ceftriaxone, Surgical site infection

## INTRODUCTION

The emergence of prophylactic antibiotics has made a huge contribution toward extending the range and complexity of surgical procedures. Since then the use of prophylactic antibiotics has exploded and now constitutes 30% of antibiotic use in general hospitals.

In the 1940's and 1950's, experiments with sporadic prophylactic administration of antibiotics such as sulfonamides and penicillin did not yield encouraging results, until in the 1960's when the importance of the timing of administration of dose emerged. The concept of single dose pre-operative antibiotic administration was mooted by Strachan *et al.* in 1977, when he compared a single preoperative dose of cefazolin with a regimen of cefazolin given for a period of 5 days postoperatively. The

infection-rate seen for single dose was 3% and in multiple doses it was 5%.

A preoperatively given dose of antibiotic (within 2 h of incision) ensures peak tissue concentration when the incision exposes the normally sterile tissue to the bacterial challenge of a non-sterile environment and the surgical instrumentation. It is seen that antibiotic given 3 h following an infective bacterial challenge (surgery) is ineffective in preventing infection, as the bacteria may start multiplying before host defenses are activated and if its concentration reaches to 100,000 organisms/g of tissue it may exceed host defense capacity.

Also following closure of the wound, its environment is sealed by local intravascular coagulation and events of early inflammation preventing any antibiotic penetration. The most prudent and conservative interpretation of the result of all the factors involved and studies undertaken is that single dose prophylaxis is as effective as multiple dosing, if not more. Also with the ever rampant use of antibiotic, single dose prophylaxis is preferable as it is less likely to alter antibiotic resistance patterns bacteria in a hospital. The present study is undertaken to compare a preoperative single dose protocol with a multiple post-

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operative doses in prevention of post-operative wound infections.

### Aims and Objectives

The objectives are as follows:

To obtain precise information on the optimal time window for surgical antimicrobial prophylaxis

Comparing single dose intravenous (IV) ceftriaxone pre-operatively versus 5 days ceftriaxone IV for prophylaxis postoperatively.<sup>[1-4]</sup>

## MATERIALS AND METHODS

### Source of Data

The study was conducted in MGM Hospital, Warangal during the period from November 2017 to April 2019. All the patients in our study were treated in general surgical ward of our hospital. The study involved 100 patients who underwent various surgical procedures. All the surgeries performed were elective cases and all patients subjected to this study were having normal general workup. All the patients were studied from the time of their admission till they were discharged and followed up to 3 weeks postoperatively. Details of the individual cases were maintained in the pro forma.

### Inclusion Criteria

Elective surgical procedures in clean and clean-contaminated cases were included in the study. Age groups between 12 years and 60 years were included in the study. Both sexes Getting admitted in MGM Hospital were included in the study.

### Exclusion Criteria

Age <12 years and more than 60 years, Immunocompromised patients, Surgeries exceeding 3 h of duration, Any history of diabetes mellitus (DM), hypertension (HTN), tuberculosis (TB), or other chronic illness, and use of prosthetic materials were excluded from the study.

A detailed history was ascertained and entered in the pro forma. A detailed previous history was recorded. History of intake of any drugs, antibiotics, and any history of the previous hospitalization, associated illness, and habits and diet were recorded in detail. Significant family history was also recorded.

General physical examination was carried out in detail, considering features suggestive of anemia and jaundice. Any sites of focal infection were also looked for. Examination of the other systems and of the part concerned was done in detail.

Routine laboratory work up was carried out preoperatively of all the patients. Culture swabs were taken on the 3<sup>rd</sup> postoperative day, the 5<sup>th</sup> post-operative day, and the 7<sup>th</sup> postoperative day, if the wound was showing purulent discharge or any other signs of infection. Antibiotics were continued if the wound showed signs of infection and the cases were followed up and further swab was taken for culture.

Protocol 1 group of patients received a single dose of 1 g ceftriaxone IV on table at the time of induction of anesthesia and no IV antibiotics were given for 24 h after surgery. Further, half of these patients received dose half-an-hour before incision and the other half received dose 1 h before incision.

Protocol 2 group of patients received no antibiotics preoperatively but received 1 g ceftriaxone IV at 12<sup>th</sup> h intervals after surgery for a minimum of 5 days. All the patients were watched closely in the post-operative period. Temperature was recorded 6<sup>th</sup> h. Postoperatively, pain whether decreasing or not was noted.

Dressings were inspected daily. Routinely dressing was changed on the 3<sup>rd</sup> post-operative day and the wound was inspected. Dressings which showed soakage or if there were signs of infection, were changed as and when needed. Wounds which showed minimum serous discharge were regularly dressed. Patients were advised to follow-up. The wounds which showed purulent discharge were dressed regularly and appropriate antibiotics were given.

Routine follow-up was done in all the cases. During follow-up, the following points were assessed

1. History of taking antibiotics after the discharge
2. Wound was inspected
3. Any sites of infections were noted
4. Routine general and systemic examination were carried out.

## RESULTS

The following data were analyzed in the study of 100 patients, 50 cases of these were given a single pre-operative dose and 50 cases were given 1 g ceftriaxone IV at 12<sup>th</sup> h intervals after surgery for a minimum of 5 days.

In this study, majority of the cases fall into age group of 21–30 years. About 65% of the cases fall between 21 and 40 years. The youngest patient was of 12 years of age and the oldest patient was of 58 years of age.

There was increase in duration of stay in the wound infected cases. The maximum stay of 14 days was noted and a minimum stay of 6 days was noted in this study. The

average number of days was 8.8 days for wound infected cases, was as it was 3.35 days for non-infected cases.

All the surgeries in this study were belonging to clean and clean contaminated groups. The most common procedure done was herniorrhaphy. All these surgeries were done in the regular setup, the duration was noted and the order of the cases in OT was recorded.

In this study of 100 cases, ten cases showed surgical site infections (SSIs). The organisms encountered were *E. coli* (4 cases), *S. aureus* (3 cases), *Pseudomonas* (2 cases), and *Klebsiella* (1 case). The 2<sup>nd</sup> swab was taken following regular dressing on 5<sup>th</sup> day from the wound. These cases required further antibiotic coverage and follow-up. The subsequent 3<sup>rd</sup> swab showed no growth.

In this study, 50 patients were given single preoperative dose of 1 g inj. Ceftriaxone. In these 50 cases, 25 cases were given injection half-an-hour before incision and 25 cases were given injection 1 h before incision, accounting for 1 and 3 SSI cases, respectively. The overall wound infection rate in Protocol I group was 8%.

Out of 100 cases studied, only ten cases showed SSIs accounting for 10% SSI rate. Protocol 1 group showed 4 SSI cases (8%) and Protocol 2 group showed 6 SSI cases (12%) [Tables 1-4].

## DISCUSSION

This study was conducted on 100 patients undergoing elective surgeries in the department of General surgery in MGM Hospital, Warangal from November 2017 to April 2019. The observations made have been discussed and the results are being compared to with other studies.

Out of the 100 cases studied, ten cases had SSI with an overall incidence of 10% infection rate. Mead *et al.*, Rajkumar *et al.*, Devenish and Miles, Singh *et al.*, Shrivatsava, Agarwal, and Patel had made similar observations to whom our present study was compared.

The scientific use of prophylactic antibiotic was laid by Miles and Burke in late 1950s when they were able to show that infection could be prevented only when antibiotics were given before at the time of infectious challenge. Following incision, the normally sterile tissue is exposed to a non-sterile environment and if the bacterial load exceeds the host defense capacity, the infection ensues. This bacterial load can be reduced by techniques of asepsis.

Following closure of the wound, its environment is sealed by local intravascular coagulation and the events

**Table 1: Age incidence**

Age group (years)	Total number of cases	Infected cases
12–20	23	01
21–30	41	04
31–40	24	05
41–50	09	00
51–60	03	00
Total	100	10

**Table 2: Sex incidence**

	Infected	Total no.of Cases	Percentage
Male	04	55	7.27
Female	06	45	13.33
Total	10	100	10

**Table 3: Duration of stay**

	Maximum Stat (Days)	Minimum (Days)	Average (Days)
Infected Cases	14	6	8.8
Non-Infected Cases	7	1	3.35
Total Cases	14	1	3.9

**Table 4: Culture report**

	1 <sup>st</sup> Swab	2 <sup>nd</sup> Swab	3 <sup>rd</sup> Swab
Total Cases	10	10	10
<i>Klebsiella</i>	1	1	-
<i>Staphylococcus aureus</i>	3	1	-
<i>Pseudomonas</i>	2	2	-
<i>Escherichia coli</i>	4	3	-

of early inflammation which initiate wound healing. This may explain the ineffectiveness of the post-operative antibiotic administration to prevent wound infection. Antibiotic administered preoperatively diffuse into the peripheral compartment (wound fluid). This prevents the contamination with invading bacteria on exposure to the environment and surgical instrumentation.

Successful prophylaxis requires the tissue concentrations of antibiotics to be at peak levels at the time of incision and the effective concentrations to be maintained till closure.

This study comparing the single preoperative dose of cefazolin with a regimen of cefazolin given for a period of 5 days after operation showed the infection rate of 3% and 5%, respectively.

In this study, Protocol 1 showed 8% infection rates whereas Protocol 2 showed 12% infection rates. Out of 50 cases of protocol 1, 25 cases received antibiotic prophylaxis half-an-hour incision accounting for 1 (4%) infected case and

25 cases received antibiotic prophylaxis 1 h before incision accounting for 3 (12%) infected cases.

All the above studies interpret that single dose prophylaxis is as effective as or even more effective than multiple dosing and is preferable as it is less likely to alter antibiotic patterns of bacteria in the hospital. In this study of 100 patients, 50 patients were given a single dose prophylaxis of 1 g inj. Ceftriaxone IV at the time of induction on table and the other 50 patients received no antibiotics preoperatively but received 1 g inj. Ceftriaxone IV at 12<sup>th</sup> h intervals. There was overall infection of 10%. All SSIs were of superficial and deep incisional type. None of them developed organ/space SSIs.

In this study, majority of the cases fall into age group of 21–30 years. About 65% of the cases fall between 21 and 40 years. Out of ten infected cases, nine belonged to the age group of 21–40 years.

Out of 55 male patients, four patients were showing wound infection. Out of 45 female patients, six patients were showing wound infection. Although no much statistical significance was observed in the study, female showed increased incidence of SSIs.

There was increase in duration of stay in the wound infected cases. The maximum stay of 14 days was noted and a minimum stay of 6 days was noted in this study. The average number of days was 8.8 days for wound infected cases, as it was 3.35 days for non-infected cases. SSIs lead to significant prolongation of hospital stay. Among the infected cases, majority were herniorrhaphy (4 cases) followed by appendectomy (2 cases), cholecystectomy (2 cases), and anatomical repair (2 cases). All the infected wounds were followed up and swabs were taken on postoperative day 3. Out of the two infected appendectomy cases, one received antibiotic 1 h before surgery while the other after the surgery.

Out of the two infected cholecystectomy cases, one received antibiotic half an hour before while the other after the surgery. Out of the four infected cholecystectomy cases, one received antibiotic 1 h before surgery while the rest after the surgery.

Out of the two infected anatomical repair cases, one received antibiotic 1 h before surgery while the other after the surgery.

The most common isolate from the SSI site was *E. coli* (4 cases), then followed by *S. aureus* (3 cases), *Pseudomonas* (2 case), and *Klebsiella* (1 case). All these were sensitive to the prophylactic antibiotic that was used.

Prophylactic antibiotics have been recommended by many research workers. This is achieved by giving broad spectrum intravenous antibiotics preoperatively and peak serum and tissue concentration is achieved within 20 min.

A recent systematic review by Kelley *et al.* concluded that antibiotic prophylaxis administered before the incision decreased the likelihood of neonatal infection. Post-operative wound infection can be reduced by taking measures such as pre-operative baths, changing clothes before the shifting the patient to operation theater, and disposables gowns. Post-operative wound infection can be superficial or deep; superficial occurring above the fascia and deep occurring below the fascia.

Post-operative superficial wound infection was 6.5% in a study by Nisa *et al.* while in our study superficial infection rate was 8% in both groups which is comparable to our study. The slight increase rate in our study can be due to poor hygiene and nutritional practices in our community.

In a study by Amenu *et al.*, wound infection rate was higher than our study because they included patients who presented with prolong rupture of membranes and underwent emergency cesarean section. Similarly, a study by Satyanarayana *et al.* had high prevalence of wound infection as compared to our study as they have included emergency cesarean sections as well.<sup>[5-7]</sup>

## CONCLUSION

Clean surgeries constitute more than three fourth of all surgical procedures, irrespective of the surgical discipline. Infection rates in this group of surgeries are a valid pointer to adoption of aseptic principles in the institution, meticulousness of surgery, and efficient care (both pre-operative and post-operative) offered to patients in the institution.

There is substantial published evidence demonstrating that antimicrobial prophylaxis after wound closure is unnecessary. Prolonged use of prophylactic antibiotics is associated with emergence of resistant bacterial strains. In view of testing this hypothesis, this retrospective study was conducted.

This retrospective study conducted with 100 patients has shown comparable infection rates in both the groups receiving antibiotic before and after the surgery. Within the group comparison in pre-operative group, with antibiotic given half an hour and 1 h before surgery, showed no significant difference in infection rate.

From this study, it can be concluded that following closure of clean and clean contaminated surgical wounds, the administration of the antibiotics is not very effective and not necessary. Single dose of 1 g inj. Ceftriaxone IV given half an hour before incision is sufficient to prevent SSIs, provided, an extra dose has to be given if the duration of the surgery has passed more than 3 h.

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