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Risk factors and role of preoperative antibiotic prophylaxis in prevention of surgical site infection

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Abstract
Surgical site infection (SSI) is one of the most frequent causes of postoperative morbidity. Surgical site infection is the most common nosocomial infection in our population accounting for 38% of all infections in surgical patients. The emergence of prophylactic antibiotics has made a huge contribution towards extending range and complexity of surgical procedures. Preoperative antibiotic prophylaxis is defined as administering antibiotics prior to performing surgery to help decrease the risk of postoperative infections. This is a prospective open label study was carried out at Department of Surgery, Rangamati Medical College, Rangamati, Bangladesh from January to December 2023. During this period, 80 cases were selected for our study purpose, all of which were clean or clean contaminated surgeries done under meticulous surgical technique. The group was split into group A and group B of 40 cases each. The study involved 80 clean and clean contaminated elective surgical cases were divided equally into two groups, Group A included 40 cases who received single prophylactic dose of 1 gm cefotriaxone given intravenously half an hour before surgery and Group B included 40 cases who did not receive any such antibiotic prior to surgery. The age incidence varied from 5 to 65 years but maximum number of patients belonged to 21 to 30 years age group. Group A had 30 clean surgical cases and 10 clean contaminated cases, out of which none of them were infected. In group B out of 30 clean cases, 1 case was infected and out of 10 clean contaminated cases 4 were infected. In the present study 6 patients in group B with obesity were found to have prolonged duration of surgery contributing to more than one risk factor for development of SSI. All the 6 patients who had prolonged duration of surgery and obesity developed surgical site infection. The 4 patients with diabetes mellitus (2 patients in each group) who had control of their diabetic status prior to surgery, none of them developed SSI. The average duration of the surgery in our study from the time of skin incision to the time of closure was 1 hour 30 minutes. There were no reports of any allergy and adverse effects to the prophylactic drug chosen. From this study we can conclude that, for clear cut cases of clean surgeries there is no need for prophylactic antibiotics, as there is no statistical significance, whereas in clean contaminated cases antibiotic prophylaxis is recommended as it is statistically significant.

Keywords: Risk factors, antibiotic prophylaxis, surgical site infection

Introduction
Surgical site infections (SSIs) are one of the most common causes of postoperative morbidity. Wound infections are the most common hospital-acquired infections in our population, accounting for 38% of all infections in surgical patients. Wound infections are the most common, accounting for 60-80% of all SSIs [1]. The introduction of prophylactic antibiotics has contributed greatly to expanding the scope and complexity of surgical procedures. Preoperative antibiotic prophylaxis is the administration of antibiotics before surgery to reduce the risk of postoperative infection. There is growing evidence supporting the routine preoperative use of prophylactic antibiotics. A 2008 study highlighted the effectiveness of antibiotic administration in hip and knee replacement surgery. The absolute risk of wound infection is reduced by more than 80% compared to patients who did not receive prophylaxis [2]. Routine administration of prophylactic antibiotics is standard when patients have artificial implants or foreign bodies inserted as part of procedures, bone grafts, and other surgeries where extensive dissection or significant blood loss is expected. Although the timing of antibiotic administration may vary, the goal of preoperative systemic antibiotic prophylaxis is to maintain baseline and intraoperative tissue concentrations as high as possible [3, 4].

The literature supports that the optimal time for preoperative administration of most commonly used antibiotics is at least 30 minutes and up to 60 minutes before skin incision [3, 5, 6]. Special attention should be paid to the ideal preoperative timing of tourniquet use, as administration is least effective when antibiotics are administered after tourniquet application [7]. The reasons for this persistent infection problem are obviously diverse, but the widespread use of antibiotics has often led to an unrealistic reliance on antibiotic effectiveness in the treatment of disease, resulting in violation of established surgical principles and the breakdown of isolation procedures. Prophylactic antibiotic therapy is obviously more effective if initiated preoperatively and continued during the intraoperative treatment period, aiming to achieve therapeutic blood concentrations throughout the entire surgical period [8].

Methodology

This is a prospective open label study was carried out at Department of Surgery, Rangamati Medical College, Rangamati, Bangladesh from January to December 2023. During this period, 80 cases were selected for our study purpose, all of which were clean or clean contaminated surgeries done under meticulous surgical technique. The group was split into group A and group B of 40 cases each. Group A comprises patients who received a pre-operative single dose of ceftriaxone a broad-spectrum cephalosporin. Group B received no such prophylactic antibiotic. The groups were split into two taking into consideration the type of surgeries, the age of the patient, the presence or absence of risk factors for development of SSI, and associated medical conditions, all of which were represented in both the groups almost equal and a comparative clinical study was made.

Upon admission to the hospital, detailed documentation was filled out including diagnosis, pre-operative tests, careful patient preparation before surgery etc. All patients were followed up for 10 days after surgery. Data was entered into the form. Wound swabs were sent for culture and sensitivity determination and patients were treated accordingly. The patient was admitted on our outpatient day. Patients were classified as clean or clean contaminated cases depending on their complaints, clinical examinations and diagnoses. Patients with distant infections such as respiratory and urinary tract infections were treated on an outpatient basis and surgery was performed after 2 weeks. All patients were admitted to hospital 2 days before surgery after a thorough examination. In selected cases, some special tests were also performed to confirm the diagnosis. Preoperative hospitalization was kept to a minimum to prevent patients from acquiring hospital-acquired infections. Diabetic patients were treated with insulin injections as a preventive measure.

Preoperative skin preparation was performed carefully. The patient was allowed a thorough scrub bath, after which the parts were prepared with povidone-iodine and the surgical site was isolated from the environment by covering it with sterile gauze [9]. The next morning, the patient was taken to the waiting room and, under aseptic precautions, received a single dose of ceftriaxone 1 g intravenously 30 minutes before surgery. All cases were performed in the morning. The patient was anesthetized under aseptic precautions. The sterile gauze was removed and the patient's skin was coated with povidone-iodine solution and spray. The surface was then dried. She was then covered with sterile towels and sheets. The operation was performed by experienced staff and graduate students, and cauterization was minimized as much as possible. Freedom of movement in the operating room was restricted. If necessary, closed suction drains were used and the wound was closed with a sterile dressing.

Patients were isolated in the postoperative ward for at least 3 days. Drains were removed on 3rd or 4th postoperative day. Wound was inspected on third day, any sign of inflammation, infection were noted down and findings were entered in the proforma. If infected, wound swab was taken and sent for culture and sensitivity and antibiotic was started immediately in all infected cases. Sutures were removed on the eighth postoperative day. Patients were followed up to fifteenth postoperative day. All the data was entered in the proforma. The available results and outcomes in both groups were studied and analyzed and then they were compared with the available previous study and final conclusion was drawn.

Results

The study involved 80 clean and clean contaminated elective surgical cases were divided equally into two groups, Group A included 40 cases who received single prophylactic dose of 1 gm cefotriaxone given intravenously half an hour before surgery and Group B included 40 cases who did not receive any such antibiotic prior to surgery. The age incidence varied from 5 to 65 years but maximum number of patients belonged to 21 to 30 years age group. Six patients in group B were infected, one belonged to 41-50 years age group three belonged to the 51-60 years age group and other two in the 61-70 years age group. Group A had 30 clean surgical cases and 10 clean contaminated cases, out of which none of them were infected. In group B out of 30 clean cases, 1 case was infected and out of 10 clean contaminated cases 4 were infected.

Table 1: Infection Rates in all cases

	Number of cases		Number of cases which got infected		Rate of infection	
	Clean	**Clean-C0ntaminated**	**Clean**	**Clean-C0ntaminated**	**Clean**	**Clean-C0ntaminated**
Group A	30	10	-	-	-	-
Group B	30	10	1	4	3.33%	40.0%
Total	60	20	1	4	1.66%	20.0%

Table 2: Showing distribution of risk factors in the affected group

Risk Factors	Group A	Group B	Total	Percentage (%)
Anaemia	3	3	6	20.0
Diabetes Mellitus	2	2	4	13.3
Obesity	3	5	8	26.6
Prolonged duration of surgery	0	6	6	20.0
Old age	3	3	6	20.0
Total	11	19	30	100

Out of 80 cases taken up for the study 30 patients were identified to have risk factors for development of surgical site infection. The frequency and distribution of risk factors are as follows: In the present study, six obese patients in group B were found to have a longer operation time, which contributed to multiple risk factors for developing postoperative wound infection. All six patients with prolonged surgery and obesity developed wound infection. Of the four diabetic patients (two in each group) whose diabetic status was controlled before surgery, none developed postoperative wound infection. The six anemic patients (who improved before surgery) did not experience a postoperative wound infection. Three of the six elderly patients developed a postoperative wound infection. These three had other risk factors.

Table-3: Showing Duration of Surgery affecting infection rate

Duration in Hours	Number of cases		Number of cases infected	Percentage of Infection
	Group A	Group B		
<1 hour	30	27	-	-
1-2 hours	10	09	1	11.1%
>2 hours	0	4	3	75.0%

All cases in this study were clean, uncontaminated elective surgeries performed by senior staff and postgraduate students. Care was taken to complete the operation as quickly and efficiently as possible. The average operative time in our study from the time of skin incision to the time of closure was 1 hour and 30 minutes. The shortest time was 35 minutes and the longest time was 2 hours. The operation of one infected patient in our study took 1 hour and 50 minutes, and the operation of the other four infected patients took more than 2 hours. No patients in either group had an infection after surgery lasting less than an hour and a half.

Table 4: Showing Infection Rate with and without Prophylactic Antibiotics in clean and clean contaminated cases

		Number of cases	Number of cases Infected	Percentage
Clean	Group A	30	-	-
	Group B	30	1	3.33%
Clean Contaminated	Group A	10	-	-
	Group B	10	3	30.0%

In the present study a third generation cephalosporins was administered half an hour before the incision under aseptic precaution to all the patients in group A and no patients in group A got infected when compared to the group B, where no such antibiotic was given and there was an infection rate of 3.33% (1 patient) in clean cases and 30.0% (3 patients) in clean contaminated cases. There were no reports of any allergy and adverse effects to the prophylactic drug chosen.

Discussion

Preoperative antibiotic selection is usually based on the anatomical region where the surgical procedure will be performed. The goal in determining the appropriate choice of antibiotic is to achieve a relatively narrow spectrum of activity while ensuring that the most common microorganisms are targeted. In addition, preoperative antibiotics are selected based on many factors, including cost, safety, ease of administration, pharmacokinetic profile, bactericidal activity, and nosocomial resistance patterns. Considering all these factors when selecting antibiotics will minimize surgical site infections (SSIs). Overall, SSIs are a significant cause of adverse patient-reported outcomes and an independent risk factor that increases the overall economic burden of the health care system [10]. Wound infections have been documented since the early days of surgery, but have never been controlled. Strict asepsis, meticulous surgical technique, and prophylactic antibiotics have dramatically reduced the incidence of SSIs. Wound infections affect all age groups, but their incidence increases with age and is more common in older groups. In our present study maximum number of cases were represented in age group 21-30 years. The age incidence in the present study varied from 5 to 65 years but maximum number of patients belonged to 21 to 30 years age group. Older age group is considered a risk factor for development of SSI, in the present study all the 5 infected cases were 60 years and above age group and one case in 41-50 years age group. Rao *et al*. [9] showed in their study that SSI incidence doubled in older age group 50-70 years. Out of 80 cases taken up for the study 30 patients were identified to have risk factors for development of surgical site infection. The incidence and distribution of risk factors is as follows. In the present study 6 patients in group B with obesity were found to have prolonged duration of surgery contributing to more than one risk factor for development of SSI. All the 6 patients who had prolonged duration of surgery and obesity developed surgical site infection. 6 patients with anemia (corrected prior to surgery) did not develop SSI. Out of 6 patients with old age 3 developed SSI, these 3 had other associated risk factors. It can be said from the present study that presence of more than one risk factor has a significant impact on the development of surgical site infection and when not provided with adequate antibiotic coverage (prophylactic antibiotic dose) are at definite risk of development of surgical site infection. Cruise and Ford have demonstrated that presence of obesity as a single independent risk factor for development of SSI and the prolonged time of surgery also increases the incidence of surgical site infection6. None of them developed surgical site infection. Hence anemia when corrected preoperatively does not pose a risk for development of surgical site infection. In the present study, 4 patients were diabetic (Group A-2, Group B-2) their blood sugar level was well controlled before and after surgery. Funary AP *et al*. in their study showed that when blood glucose level were kept strictly below 200 mg/dl during the perioperative period by continuous intravenous infusion of insulin reduced the incidence of SSI from 24% to 6.06% which was statistically significant [11]. None of the patients got infected so it can be said that with the proper control of diabetic status, infection rate can be reduced. In the present study the overall incidence of infection in the study group B was 4% compared to be nil in study group A. In the present study for clean cases, incidence of infection in group B was 3.33% compared to nil in group A, that means the difference in occurrence of infection between two study groups was found to be non-significant (P= 0.3207). Whereas for clean-contaminated cases incidence of infection in group B was 30.0%, that means the difference in occurrence of infection in two study groups was found to be significant (P=0.0365). Surgical site infections may occur for various reasons, including, but not limited to, incorrect antibiotic usage. When considering antibiotic prophylaxis practices, the correct antibiotic dosage, timing of the initial dose, and timing of any applicable redosing are major factors to review to ensure best practices are always followed. If an institution recommends a specific antibiotic in surgery when additional antibiotics are options, monitoring should ensure no surgical site infections occur due to increasing local resistance.

Conclusion

From this study, it can be concluded that in clean surgical cases, prophylactic antibiotics are not necessarily due to lack of statistical significance, but in clean contaminated cases, prophylactic antibiotics are recommended due to statistical significance. Routine administration of prophylactic antibiotics is standard when artificial implants or foreign bodies are placed in patients as part of procedures, bone grafts, and other surgeries involving extensive dissection and where significant blood loss is expected. This activity will focus on the rationale, timing, drug selection, coverage, and monitoring relevant to the members of the multidisciplinary team involved in administering preoperative antibiotic prophylaxis to patients.

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