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Research Article

Prophylactic and Therapeutic Use of the Antibiotics in Open Surgical Procedures: A Clinical Review

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Abstract: Postoperative wound infection is a common problem in hospitalized patients. Various measures have been advocated to limit or prevent the post operative wound sepsis. To overcome this burning problem one such tool is use of prophylactic antibiotic therapy. The study was carried out to assess the role of prophylactic and therapeutic use of antibiotics in open surgical procedures to prevent wound infection following surgery. Total 1540 operated cases were included in the study. They were grouped in 3 categories like clean, clean-contaminated and contaminated cases group. The different antibiotics were used in 8 groups. Patients were observed till discharge from the hospital. In this study we found that in clean and clean-contaminated surgery where prophylactic antibiotics were used the infection rate was less as compared to cases where only therapeutic antibiotics were used. The use of prophylactic antibiotics is effective tool in preventing postoperative wound infection in open surgical procedures. Antibiotic administration can reduce the incidence of postoperative wound infection where there is high likelihood of infection.
Keywords: Antibiotics and their use, Post operative wound infection, Surgical procedures

INTRODUCTION

Postoperative wound infection is still a major limiting factor in surgery, in spite of a considerable progress in both prevention and treatment of infection. It is a frequent cause of morbidity and mortality in surgical patient. Empirical use of the antibiotics in surgery has been in practice since long to overcome the postoperative wound sepsis. However, postoperative wound sepsis remains a common problem in hospitalized patients. The economical, physical and psychological impact of postoperative wound infection mandates the use of preventive methods to decrease the incidence of such complications. To overcome this burning problem of postoperative wound infection, prophylactic antibiotic therapy came as a tool to the surgeon's hand.

The rational behind prophylactic antibiotic is that administration of antibiotics after three hours of contamination does not prevent the postoperative wound infection and the therapeutic tissue concentration of antibiotics must be optimal during operative procedures to prevent infection. The prophylactic use of antibiotics prior to surgery has been found to be more useful than administering them after the operation to prevent postoperative wound sepsis. Hence the role of prophylactic antibiotics does merit in surgical practice.

The present study was carried out to assess the role of prophylactic antibiotics in prevention of wound infections following clean and clean-contaminated surgery.

Aims and Objectives

Following were the aims and objectives of this study.

- To assess the role of prophylactic antibiotics in prevention of wound infection following clean and clean-contaminated open surgical procedures
- To assess the role of therapeutic antibiotics in treatment of wound infection following clean and clean-contaminated and contaminated open surgical procedures.
- To study the advantages of prophylactic antibiotics over traditional practice of postoperative antibiotic administration.

- To find out the incidence of wound infection and to evaluate the factors responsible for wound infection.

MATERIALS AND METHODS

This study was carried out in a two year period. Out of the total operations carried out in the department of surgery, Government Medical College, only 1540 cases were included in this study, which were clean, clean contaminated and contaminated cases. The study was carried out after the prior permission from the institutions local ethical committee. All the patients agreed to take part in the present study. Patients from all age groups and of both sexes were studied.

Blood investigations including hemogram, liver function tests, kidney function tests, blood sugar level, serum proteins and urine examination were done. Patients were observed till discharge from hospital.

Wound was said to be infected when there was pus discharge, minor wound gape and major wound gape with infection. Pus swab was sent for culture and sensitivity from every infected wound.

Classification of wounds

According to the National Research Council wound classification criteria, the wounds were classified as follows.

- **Clean wound**

  Elective (not-urgent or emergency), primarily closed, no acute inflammation or transaction of gastrointestinal, oropharyngeal, billiary or tracheobronchial tracts, no technique breaks (e.g. elective inguinal herniorrhaphy)

- **Clean-contaminated wound**

  Urgent or emergency case that is otherwise 'clean', elective, controlled opening of gastrointestinal, oropharyngeal, biliary or tracheobronchial tracts; minimal spillage and/or minor technique break; reoperation via 'clean' incision within 7days; blunt trauma, intact skin, negative exploration (e.g. vagotomy, pyloroplasty)

- **Contaminated wound**

  Acute, non-purulent inflammation (note absence of purulence); major technique break or major spill from hollow organ; penetrating trauma less than 4 hours old; chronic open wounds to be grafted or covered.

- **Dirty infected**

  Purulent or abscess, preoperative perforation of gastrointestinal, oropharyngeal, biliary, tracheobronchial tracts; penetrating trauma more than 4 hours old.

Antibiotics used

The different antibiotics used were ampicillin, cefotaxime, ciprofloxacin, cotrimoxazole, amoxicillin + clavulanic acid, Cefoperazone, Cefixime, Gentamicin, Amikacin, Tetracycline, and Metronidazole.

Ampicilin, cefotaxime, ciprofloxacin and cefoperazone were used singly or in combination with metronidazole and/or gentamicin or amikacin. Other antibiotics were added according to culture and sensitivity of pus after the development of wound infection. Intra operative antibiotics were used where operations lasted for more than 2 hours.

In clean, clean-contaminated and contaminated cases (in 1530 out of 1540) prophylactic antibiotics were used in different groups as follows. In clean cases, 10 patients received no antibiotics at all.

Sl. No.	Antibiotic used	No. of cases
1	Only induction dose of Ampicillin	179
2	Only induction dose of Cefotaxime	168
3	Ampicillin for 1 day	259
4	Cefotaxime for 1 day	224
5	Ampicillin + Gentamicin for 1 day	83
6	Cefotaxim + Gentamicin for 1 day	80
7	Cotrimoxazole for 1 day	21
8	Co-amoxyclav for 1 day	19

In clean-contaminated and contaminated cases, empirical antibiotic therapy was used in different groups as follows.

Sl. No.	Antibiotic used for 3 days	No. of cases
1	Ampicillin + Metronidazole	115
2	Cefotaxime + Metronidazole	241
3	Ciprofloxacin + Metronidazole	15
4	Cefoperazone + Metronidazole	18
5	Ampicillin + Metronidazole + Gentamicin	30
6	Cefotaxime + Metronidazole + Gentamicin	26
7	Ciprofloxacin + Metronidazole + Gentamicin	15
8	Cefoperazone + Metronidazole + Gentamicin	15
9	Ampicillin + Metronidazole + Amikacin	11
10	Cefotaxime + Metronidazole + Amikacin	11

In all infected cases, the antibiotic therapy was continued for 3 days, 7 days and more than 7 days according to the culture and sensitivity of organisms till the infection was subsided.

RESULTS

In this study following observations were made.

Table 1: Prophylactic antibiotics and incidence of wound infection in clean and clean-contaminated surgery

Sl. No.	Antibiotics	No. of cases	Cases infected	Percentage
1	Only induction dose of Ampicillin	179	11	6.14
2	Only induction dose of Cefotaxime	168	8	4.76
3	Ampicillin for 1 day	259	18	6.94
4	Cefotaxime for 1 day	224	20	8.92
5	Ampicillin + Gentamicin for 1 day	83	7	8.43
6	Cefotaxime + Gentamicin for 1 day	80	5	6.25
7	Cotrimoxazole for 1 day	21	1	4.76
8	Coamoxiclav for 1 day	19	1	5.26
	Total	1033	71	6.87

The above observation table shows that in clean and clean-contaminated surgery where prophylactic antibiotics were used, the infection rate was 6.87 % and it was more or less same in different groups.

Table 2: Empirical antibiotics and incidence of wound infection in clean-contaminated and contaminated surgery

Sl. No.	Antibiotics	No. of cases	Cases infected	Percentage
1	Ampicillin + Metronidazole	115	53	46.08
2	Cefotaxime + Metronidazole	241	97	40.24
3	Ciprofloxacin + Metronidazole	15	3	20
4	Cefoperazone + Metronidazole	18	2	11.11
5	Ampicillin + Metronidazole + Gentamicin	30	4	13.33
6	Cefotaxime + Metronidazole + Gentamicin	26	6	23.07
7	Ciprofloxacin + Metronidazole + Gentamicin	15	2	13.33
8	Cefoperazone + Metronidazole + Gentamicin	15	2	13.33
9	Ampicillin + Metronidazole + Amikacin	11	2	18.18
10	Cefotaxime + Metronidazole + Amikacin	11	3	27.27
	Total	497	174	35.01

The above table shows that in clean-contaminated and contaminated surgery where empirical antibiotics were used for 3 days, the infection rate was 35.01 % and it was minimum with cefoperazone + metronidazole combination (11.11%) and maximum with ampicillin + metronidazole combination (46.08%).

In the infected cases where pus culture was sterile or the organisms isolated were resistant to the antibiotics used for sensitivity, the empirical antibiotic therapy was continued till the infection was subsided and in the cases where the organisms were sensitive, antibiotics were added as per the culture sensitivity of organisms till the infection was subsided.

Table 3: Therapeutic use of antibiotics in infected clean and clean-contaminated cases

Sl. No.	Antibiotics and Duration (in days)	No. of cases	Total utility of antibiotics in days
1	Ampicillin (3)	25	3
2	Cefotaxime (3)	13	3
3	Ampicillin + Gentamicin (3)	5	3
4	Cefotaxime + Gentamicin (3)	2	3
5	Ampicillin + Gentamicin + Coamoxiclav (3)	1	6
6	Ampicillin + Gentamicin + Ciprofloxacin (3)	3	6
7	Ampicillin + Gentamicin + Tetracycline (3)	1	6
8	Ampicillin + Cefixime (2)	2	7
9	Cefotaxime + Cefixime (2)	6	7
10	Ampicillin + Cefotaxime (5)	4	8
11	Cefotaxime + Gentamicin + Cotrimoxazole (7)	1	10
12	Ampicillin + Gentamicin + Cotrimoxazole (7)	3	12
13	Cefotaxime + Ciprofloxacin (5)	1	13
14	Cefotaxime + Gentamicin + Cefixime (10)	1	13
15	Cefotaxime + Gentamicin + Ciprofloxacin (10)	2	13
16	Ampicillin + Ciprofloxacin (5)	1	15

Table 4: Therapeutic use of antibiotics in infected clean-contaminated and contaminated cases

Sl. No.	Antibiotics and Duration (in days)	No. of cases	Total utility of antibiotics in days
1	Ampicillin + Metronidazole (5)	35	7
2	Cefotaxime + Metronidazole (5)	17	7
3	Ampicillin + Metronidazole (3) + Ciprofloxacin (4)	3	7
4	Cefaperazone + Metronidazole (3) + Cefixime (4)	2	7
5	Ampicillin + Metronidazole (5) + Gentamicin (3)	6	8
6	Cefotaxime + Metronidazole (5) + Gentamicin (3)	4	8
7	Ciprofloxacin + Metronidazole (5) + Gentamicin (3)	4	8
8	Cefaperazone + Metronidazole (5) + Gentamicin (3)	3	8
9	Ampicillin + Metronidazole (5) + Cefixime (5)	3	10
10	Cefotaxime + Metronidazole (5) + Cefixime (5)	54	10
11	Ampicillin + Metronidazole (5) + Amikacin (5)	2	10
12	Cefotaxime + Metronidazole (5) + Amikacin (5)	5	10
13	Cefotaxime + Metronidazole (5) + Gentamicin (3) + Cefixime (2)	3	10
14	Cefotaxime + Metronidazole (5) + Ciprofloxacin (5)	11	10
15	Ampicillin + Metronidazole (5) + Gentamicin (3) + Cefixime (4)	2	12
16	Cefotaxime + Metronidazole (5) + Cotrimoxazole (7)	1	12
17	Cefotaxime + Metronidazole (5) + Ampicillin (7)	16	12
18	Ampicillin + Metronidazole (5) + Gentamicin (3) + Ciprofloxacin (5)	1	13
19	Cefotaxime + Metronidazole (5) + Gentamicin (3) + Ciprofloxacin (5)	2	13

Table 5: Clean surgery without antibiotics and without incidence of wound infection

Antibiotics	Cases	Cases infected	Percentage
No antibiotics	10	Nil	nil

As per above table the infection rate was nil in clean cases where patients received no antibiotics at all.

Table 6: Incidence of wound infection in relation with sex of patient

Sex	cases	Cases infected	Percentage
Male	1050	176	16.76
Female	490	69	14.08

Table 7: Incidence of wound infection in relation with age of patient

Age (in years)	cases	Cases infected	Percentage
< 10	192	8	4.16
11-20	213	27	12.67
21-30	291	31	10.65
31-40	359	39	10.86
41-50	223	23	10.31
51 & above	262	117	44.65

Table 8: Incidence of Emergency / plan operations and wound infections

Operation	Cases	Cases infected	Percentage
Plan	1048	86	8.20
Emergency	492	159	32.31

Table 9: Incidence of wound infection in clean surgery

Operations like	Cases	Cases infected	Percentage
Hernioplasty, Hrniotomy, Thyroidectomy, Mastectomy etc	783	59	7.53

Table 10: Incidence of wound infection in clean-contaminated surgery

Operations like	Cases	Cases infected	Percentage
Pyelolithotomy, Cholecystectomy, Laparotomy etc	590	90	15.78

Table 11: Incidence of wound infection in contaminated surgery

Operations like	Cases	Cases infected	Percentage
Laparotomy (Perforation Peritonitis)	167	96	57.48

Table 12: Incidence of wound infection and intra operative focus of infection

Intra operative focus of infection	Cases	Cases infected	Percentage
Present	207	114	55.07
Absent	1333	131	09.82

Table 13: Incidence of wound infection and site of operation

Site of operation	Cases	Cases infected	Percentage
Abdomen	553	166	30.01
Anterior neck	58	6	10.34
Breast	130	18	13.84
Inguinal region	375	11	02.93
Scrotal region	52	7	13.46
Suprapubic region	131	13	9.92
Lumbar region	53	3	5.66

DISCUSSION

In this study the role of prophylactic and therapeutic use of the antibiotics in open surgical procedures was studied. In this study prophylactic antibiotics were used in 1033 cases of clean and clean-contaminated cases in 8 different groups. Out of 1033 cases, 71 cases were infected and the infection rate was 6.87 %. The incidence rate was more or less same in all 8 groups.

In clean-contaminated and contaminated operations, empirical antibiotics were given in 497 cases in 10 different groups. Out of 497 cases, 174 cases were infected and the infection rate was 35.01 %. In this study the overall infection rate in clean, clean-contaminated and contaminated operations was 15.90%. The infection rate was increased with the amount of contamination.

Kayastha *et al*. [1] observed that the use of prophylactic antibiotic if administered preoperatively does have a beneficial effect in preventing bacteremia and subsequent wound sepsis. Sheridan *et al*. [2] in his study of patients undergoing clean breast cancer and hernia surgery found that patients treated withprophylactic antibiotics had 48 % fewer infections than those that did not receive prophylactic antibiotics. In the present study the infection rate (6.87) was more than that observed by Hota *et al*. [3] (1.6%).

The infection rate was more in ampicillin + metronidazole group i.e. 53 cases (46.08%) and less in cefoperazone + metronidazole group i.e. 2 cases (11.11%). Empirically many surgeons who favour prophylactic antibiotic use a cephalosporin. This is according to the various studies done like Bold *et al*. [4], Platt *et al*. [5], Coit *et al*. [6].

In the infected cases where the pus culture was sterile or the organisms isolated were resistant to the antibiotics used for sensitivity, the empirical antibiotic therapy was continued till the infection was subsided and in the cases where the organisms were sensitive, antibiotics were added according to the culture sensitivity of organisms till the infection was subsided.

In this study 10 clean cases were carried out without antibiotics where the infection rate was nil. Johnstone *et al*. [7] observed that there was no infection in 5 patients not given antibiotics in the study of prophylactic antibiotics. Anderson *et al*. [8] and Grottrup *et al*. [9] observed that in placebo controlled trials; the 'no antibiotic' wound infection rates range from 4 to 9% for simple appendicitis. Cruse *et al*. [10] in his study they found that the clean wound infection rate is the most sensitive indicator of surgical technique.

In the present study the overall infection rate was 15.90%. The infection rate was directly associated with the amount of contamination; the infection rate being more in contaminated operations i.e. 57.48 % and least in clean operations i.e. 7.53 %.

The infection rate was maximum in age more than 50 years (44.65%) and minimum in younger age group (4.16%) because of decreased immunity at older age. Also old age is associated with diabetes mellitus, obesity, vascular diseases etc. Cruse *et al*. [10] and Agrawal *et al*. [11] concluded that the wound infection was more in older age group in clean surgeries. Old patients are six times more likely to develop wound infection than the younger patients.

The infection rate in both the sexes was more or less same. In males it was 16.76% and in females 14.08%. The same findings were observed by Agrawal *et al*. [11] and Khan *et al*. [12].

Infection rate was more in emergency operations (32.31%) than in plan operations (8.20%). Studies [10, 11] have shown that the emergency operations are prone to develop wound infection because of the environmental factors and the already infected cases.

The infection rate was maximum in patients where the site of operation was abdomen (30.01%) and in operations having presence of intra operative focus of infection (55.07%). Dineen *et al*. [13] and Haley *et al*. [14] also noticed the more wound infection rate in patients undergoing operations involving the abdomen.

CONCLUSION

We conclude that the use of prophylactic antibiotics in clean and clean-contaminated surgery is justified. At the same time the use of therapeutic antibiotics in clean-contaminated and contaminated surgery is also effective. The incidence of wound infection was more in aged group of patients, patients having more degree of contamination, emergency operations and I patients with presence of intra operative focus of infection. The incidence of infection was more or less same in both sexes. In 10 cases of clean operations where no antibiotics were used at all, the infection rate was nil.

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