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Single Dose Antibiotic as Antimicrobial Prophylaxis in Planned Surgical Procedures

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Abstract **Original Research Article**

Despite the high standards of sterilization post operative surgical site infection is common. Single dose of prophylactic antibiotic at the time of induction of anesthesia could brought down the incidence of wound infection considerably .Our aim of study were to assess the efficacy of single dose of commonly used broad spectrum antibiotics in clean and clean contaminated cases in prevention of postoperative wound infection. Total 125 patients divided into five groups are selected for study between May 2017 to October 2018 in surgical ward of Mahatma Gandhi hospital Jaipur India. All groups except one given single dose of antibiotic at the time of induction of anesthesia .In all five groups, postoperative evaluation of the wound was done & any discharge from the wound was sent for bacteriological culture and sensitivity testing. Post operative surgical site infection rates were compared. Current study did not demonstrate a difference in the rate of infection between patients receiving preoperative antibiotics alone (1.56%) versus those receiving preoperative followed by postoperative multiple doses of antibiotics (1.20%, P = 0.711). Only a single dose of antibiotic administered at the time of induction of anesthesia is able to prevent post operative wound infection efficiently and minimize side effects and hospital expenditures.

Keywords: Single dose antibiotic, prophylactic antibiotic, surgical site infection, postoperative wound infection.

INTRODUCTION

Despite the high standards of sterilization of surgical instruments, dressing, improved operating theatre designs, minimally invasive and strict aseptic techniques, many patients whose wounds are expected to heal by first intention suffer the discomfort, inconvenience and sometimes the actual danger of a wound sepsis.

Many serious and time consuming operations performed with great skill and labor get spoiled in a minute by a tiny microbe - most common being the naughty staphylococcus. The various neurosurgical, cardiothoracic, plastic and general surgeries whose expertise have already sucked nearly half of a surgeon's carrier, are casted into tears of pus in the wound by these selfish microbes.

Postoperative wound infection may be the results from many causes out of which 'microbial contamination' is the factor which is influenced by antibiotic administration. ALTIMIER in 1965 recognized that the most important factor in the pathogenesis of wound infection is the presence of bacteria in the incision at the time of wound closure [1].

The term 'prophylactic antibiotic' implies that a microorganism is attacked by an antimicrobial agent at the time of its lodgment in surgical wound or body cavity before colonization takes place, certainly before suppuration and invasive infection begins. The aim is to prevent the development of the surgical wound infection, rather than to treat the process after it is already established.

Many methods have been evolved to combat surgical wound infection over a period of time. In the very early phase the antibiotics were only administered post operatively for treatment of already established surgical wound infection. Later on the concept of antibiotic prophylaxis was introduced. Initially the antibiotics were administered post-operatively for a prolonged period but 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.

Now days, it has been customary to opt for empirical use of prolonged antibiotic prophylaxis starting on the day of operation and continuing it for 5 to 7 days thereafter. The bacterial population can be markedly altered by such a prolonged prophylactic therapy with suppression of normal microbial flora and with the emergence or overgrowth of resistant bacteria. A lot of antibiotics are still being used even by millennium doctors, without recognizing their ill effects and cost to an average Indian citizen.

More recently, the Trial to Reduce Antimicrobial Prophylaxis Errors (TRAPE) examined the association, between surgical site infection and timing of prophylaxis in cardiac. Orthopedic and hysterectomy patients [2]. The TRAPE investigators found that SSI risk was lowest in those patients who received prophylaxis within 30 minutes (if given cephalosporins) or within 1 hour (if given vancomycin or a fluoroquinolone) prior to incision. Post incision administration was associated with a significantly increased risk for SSI.

By giving a single dose of antibiotic immediately before operation and keeping its blood level rise 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. Hence it is obvious to ask - why to opt for such a prolonged regimen of antibiotics, when a SINGLE DOSE of antibiotic is not only capable of preventing post operative surgical wound infection but can also minimize their ill effects and expensiveness.

Aims and objectives

- To assess the efficacy of single dose of commonly used antibiotic given as antimicrobial prophylaxis in prevention of post operative wound infection.
- To minimize the ill effects of prolonged use of prophylactic antibiotic therapy.
- To prevent the suppression of normal sensitive microbial flora and emergence of resistant bacteria seen with prolonged antibiotic prophylaxis.
- To reduce the expenditure born by the patient due to prolonged antibiotic use without affecting the final results of operation.

MATERIAL AND METHODS

The present prospective randomized study, a total of 125 patients admitted in surgical wards of Mahatma Gandhi Hospitals, Jaipur India between May 2017 to October 2018, were studied. All patients underwent elective surgeries. Ethical clearance has been taken.

PATIENT SELECTION

- Patients of either sex or age between 18–60 years were included in the study.
- Patients with history to allergy to any of the antibiotics were excluded from the study, though no such patient was encountered.
- Patients who had received antibiotics within previous 7 days before operation were excluded from the study except group E.
- Patients who had existing indication for antibiotic prophylaxis (i.e. valvular heart disease) and known renal or liver impairment (potentially immunocompromised) patients were excluded from study.
- All patients were investigated for anemia, tuberculosis, diabetes mellitus, cardivascular disease. Patients with serum creatinine more than 2mg/dl were excluded from the study to avoid the possibility of nephrotoxicity.
- All patients were given antibiotics intravenously at the time of induction of anaesthesia exept group E in which full course of antibiotic including one day prior and 5 days post-surgery were given.
- Patients were randomized into five groups according to the antibiotics they received. Each group comprises of 25 patients.

GROUP A: - CEFTAZIDIME
GROUP B: -PIPERACILLINE TAZOBACTUM
GROUP C: -AMOXYCILLIN & CLAVULANIC ACID
GROUP D: -CEFOPARAZONE SULBACTUM
GROU E: - FULL COURSE OF ANTIBIOTIC

Following points were kept in mind while choosing these four drugs -

- Broad-spectrum, fewer side effects, easy or hospital availability, cost effectiveness.

PRE-OPERATIVE METHODS

- Shaving was done 1 hour prior to surgery with disposable blades followed by application of clean water to scrub the area with bathing soap.
- Antibiotic sensitivity testing was done in every case prior to operation in the ward itself.
- Patient was shifted to the operation theatre after applying a sterile bandage over the proposed part of surgery to avoid the contact with airborne microorganisms. Patients were given clean gowns to wear and then enter inside the operation theatre.
- In the operation theatre, sterile bandage was removed and skin preparation was done by scrub followed by Povidone Iodine paint and Spirit.
- Cotton drapes were used in all cases.
- Operations were performed under Local/Spinal/General anesthesia.

INTRA-OPERATIVE METHODS

- Single dose of planned antibiotic according to patient's body weight was administered intravenously after diluting with required amount of distilled water at the time of induction of anaesthesia using a disposable sterile syringe.
- Duration of surgery was less than 2 hrs.
- Spillage or soiling of wound and the type of suture material used for wound closure were particularly noted.
- After closure of the skin, wound was dressed with airtight closed dressing.

POST-OPERATIVE FOLLOW UP

1. Wound were examined after taking aseptic precaution so that not to introduce any infection from outside. This was done on second, third, fourth & sixth day of operation.
2. Wounds were looked specially for -
    - Redness
    - Swelling
    - Temperature
    - Tenderness
    - Discharge and its type.
3. If the patient complained of pain, then wound was opened immediately, taking due aseptic precautions.
4. Any discharge if present, was collected in a sterile manner and sent for culture & sensitivity.
5. After uneventful seventh postoperative day, stitches were removed and patient was discharged. Patient was followed again in second week in Out Patient Department.

RESULTS

ALTIMER *et al*. - classified wound as

- CLEAN - Operation which did not transect the Genito-urinary, Gastro-Intestinal, Tracheo-Bronchial system and not in the vicinity of any Inflammation & performed under aseptic circumstances.
- CLEAN CONTAMINATED - Operation in which a viscus known to contain bacteria was opened or transected.
- CONTAMINATED - Operation associated with gross spillage at the time of viscera transaction or there was a major breach in the aseptic technique.
- DIRTY - Continued combination by fecal, Genito-urinary, Trachio-bronchial discharges or through which drainage of purulent material was effected.

Only clean and clean contaminated cases were included in study.

Post-operative wound infection

This was defined in this study, by combining the criteria's laid down by Burton *et al*. [3] and Griffith *et al*. [4] & graded as follows

Grade I -Healed wound: No discharge: Culture sterile.

Grade IIa -Erythema: Serosanguinous discharge: Sterile culture.

Grade III -Stitch abscess: Scan ty pus: Positive culture: Mild wound gaping.

Grade IV -Purulent discharge with constitutional symptom: Positive Secondary sepsis was considered when an initial discharge of blood or serum turned to be purulent.

In all five groups, postoperative evaluation of the wound was done & any discharge from the wound was sent for bacteriological culture and sensitivity testing.

- Grade I & IIa were considered as noninfected while Grade IIb, III & IV were considered to be infected wounds.

During surgery all available antiseptic and aseptic precautions were taken. Patients were followed up in the wards for the development of any of the evidence of wound infection.

The following table demonstrates the different types and nature of operation performed in various experimental groups and their comparative analysis of wound sepsis rate.

Table-1: Case related analysis types and nature of operation performed

Cases	Group A		Group B		Group C		Group D		Group E	
	No. pt. inf	(%)	No. pt. inf	(%)	No. pt. inf	(%)	No. pt. inf	(%)	No. pt. inf	(%)
CLEAN										
Hernia	5	-	6	-	6	-	6	1 (16)	5	-
Hydrocele	3	-	3	-	3	-	3	-	4	-
Fibroadenoma	4	-	4	-	4	-	4	-	3	-
Sebaceous cyst	2	-	3	-	3	-	3	-	3	-
Thyroid	1	-	1	-	1	-	1	-	1	-
CLEAN-CONTAMINATED										
Gallbladder stone	6	1(16)	3	1(33)	4	-	4	1(25)	6	1(16.6)
Appendix	2	-	2	-	1	-	1	-	0	-
Renal calculus	1	-	2	-	1	-	1	-	2	-
BPH	1	1(100)	1	-	2	-	2	-	1	-

Table-2: Wound sepsis in relation to type of surgery

Type of Surgery	Total Cases	Infected	Percentage
Clean	82	1	1.21%
Clean contaminated	43	5	11.62%

Infection rate in clean surgical procedures was 1.21% while in clean contaminated surgeries it was 11.62%, wound infection rate in clean surgeries in group D was 16%. No wound infection was reported in group A, B C and E. Wound infection rate in clean contaminated surgeries in group A was 20% in group B was 12.5% and in group D 12.5%. There was no infection reported in group C.

Comparison of major septic events

This study depicts the major septic events including wound infection, remote infection like urinary tract infection; thrombophlebitis; deep vein thrombosis, chest infection or death.

Table-3: Major septic events

	Group A	Group B	Group C	Group D	Group E
No. of evaluated patients	25	25	25	25	25
No. of wound infection	2	1	-	2	1
Chest infection	-	-	-	-	-
Death	-	-	-	-	-

This study shows that six patients had clinical and bacteriological evidence of wound sepsis none of them had any kind of remote infection or chest infection and death was also not reported in any patient.

Types of microorganisms grown in wound sepsis

Culture report obtained from wound discharges were analyzed for aerobic, anaerobic and mixed infection.

Table-4: Microorganism in wound sepsis

Experimental Group	Staph. Aureus		Esch. Coli		Klebsiella		Mixed		Anaerobic	
	Total	%	Total	%	Total	%	Total	%	Total	%
A(n = 25)	1	4	1	4	-	-	-	-	-	-
B (n = 25)	1	4	-	-	-	-	-	-	-	-
C (n = 25)	-	-	-	-	-	-	-	-	-	-
D (n = 25)	1	4	1	4	-	-	-	-	-	-
E (n = 25)	1	4	-	-	-	-	-	-	-	-

Above study shows that Staphylococci (66.6%) was the commonest organism cultured from the infected wound followed by E.coli (33.3%) and none of the culture reported were positive for mixed anaerobic or any other micro-organism.

Table-5: Overall wound infection rate

Group	Total No. of patients	Pt. infected	%
Single dose of antibiotic	100	5	5
Multiple doses of antibiotic	25	1	4

Above table shows that overall incidence of wound infection in patients who had taken single dose of antibiotic is 5% which is almost equal or slightly higher than the incidence of wound infection 4% in patients who received multiple doses of antibiotics (p=0.8).

Out of 100 cases in which single dose of antibiotic given only 5 patients had clinical and bacteriological evidence of wounds sepsis.

Overall incidence of wound infection was 5% with 8% evidence of wound infection in patients who received Cefazidime or Cefoparazone-Sulbactum and 4% in patients who received Piperacillin-Tazobactum. Surprisingly no evidence of even a single case of wound infection was reported in patients receiving Amoxicillin- Clavulanic acid.

Infection Rate in clean surgical procedures was 1.5% while in clean contaminated surgeries it was 11.62%. Wound infection rate in clean surgeries with Cefoparazone-Sulbactum was 6.25% no wound infection reported in other three groups. Wound infection rate in clean contaminated surgeries with Ceftazidime was 20% with Piperacillin-Tazobactum and Cefoparazone-Sulbactum was 12.5%. No wound infection was reported with Amoxicillin-Clavulanic acid.

In both clean, as well as clean contaminated surgeries, best results were obtained when Amoxicillin Clavulanic acid. Staphylococcus aureus was the commonest isolated from infected wound and was responsible for 60% of wound infections. Second common organism was E. coli accounting for 40% cases of wound infection. Klebsiella, anaerobic organism was not found in the wounds on culture.

No incidence of intra-abdominal infection, any remote infection like urinary tract infection, pneumonia or death was noted in any patients in the entire study. No adverse effect was noted with any of the antibiotics in any patients.

DISCUSSION

The fist available literature regarding single dose prophylactic antibiotic was from A.V. POLLOCK & D.S. TINDAL who administered a single dose of 500 mg of Ampicillin immediately preoperatively and their result showed no significance difference in wound infection with single preoperative dose of Ampicillin [5].

The prevention of operative wound sepsis was reviewed early, as a possible virtue of antimicrobial therapy. Antibiotics that produce systemic effects, given just before and after operation favorably influenced operative wound infection as reported by POLK and LOPEZ - MAYOR in 1969[6]. BOERINGER in 1995 concluded in his study that prophylactic antibiotics reduce septic complications after gastrointestinal surgical procedures [7].

The purpose of the present study was to examine the influences of a single antimicrobial agent on the incidence of wound sepsis on patients undergoing elective surgical procedures. Whether a single dose of prophylactic antibiotic is good enough to take care and 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.

The infection rates in clean wounds as reported by Cruse *et al*. in different studies conducted in the year 1973 and 1980 were 1.8% and 5% respectively [8].

If we talk about Indian settings where the exposure to operation theatre atmosphere carries an increased risk of operative wound contamination at the time of surgery. The incidence of postoperative wound infection in clean surgeries in Indian settings is as follows:

Table-7: Post-operative wound infection rate in clean surgeries in India

Year	Study by	Wound infection rate (%)
1964	CHAWLA *et al*. [9]	18.2
1973	PRAKASH *et al*. [10]	10.7
1996	SAHA *et al.*	7.1
2017	BORADE *et al.*	4.47
2018	PRESENT STUDY	1.5

The reason for higher incidence of SSI in BORADE *et al*. [11] study were inadequate dosing in obese patient and non-adherence to all standard guidelines as study shown.

The declining incidence of post operative wound infection rate in Indian settings particularly in the last decade is probably due to following of standard guideline prescribed by NICE and CDC increased awareness of aseptic and antiseptic precautions [12], the dreaded diseases like AIDS and Hepatitis B have made every surgeon to be over cautions starting right from entering in to the operation theatre and then finally leaving the theatre after operation. It is needless to stress that this encompasses the washing of hands, wearing of sterile gown and gloves which all forms the

important keys in keeping the patients infection free. The newer techniques of article sterilization (Autoclaving, Gamma radiation etc.), improved theatre care, and cleanliness have all led to increase in the operation theatre standard in the past few years.

The postoperative wound infection rate in the present study in clean surgeries is 1.51 % and in clean contaminated surgeries in the present study is 11.76%.

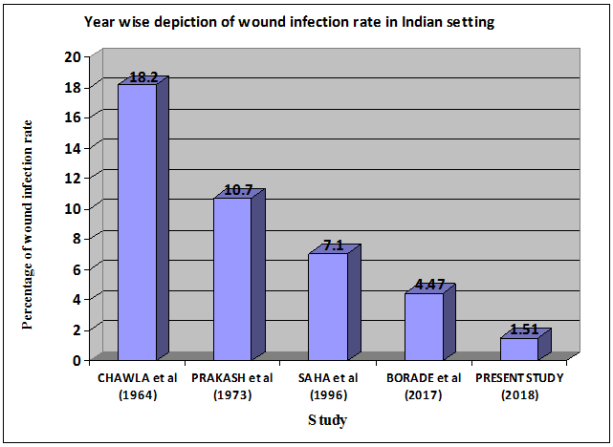

Fig-1

The above graph is representative of declining wound infection rate in the past few years in Indian settings. The prophylaxis of primary wound sepsis depends principally on taking measures to minimize exogenous and endogenous wound contamination and the use of potent antibiotic parenterally.

Evans and Pollock in 1973 reported dominance of Staphylococci in clean wounds and intestinal organism in contaminated wounds. Sundararaman and reports of public health laboratory service in 1960 quote very high figure of Staphylococci isolation i.e. 50% and 45% respectively [13]. In the present study Staphylococcus aureus was the commonest organism isolated from the cultures of infected post operative wounds 60% while E. coli was isolated in 40% of wound cultures. Anaerobic organism was 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 theatre as shown by studies of many workers (Brown -1959; Shooter -1956) [14] 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 organism (Barber 1961, public health Laboratory Service-1960, Finland -1959, Yow 1952). Culbertson in 1961 showed increased isolation of Gram negative organisms from the wounds where operations were performed on gastrointestinal tract. Similar observations were also May by Dineen [15].

The current study did not demonstrate a difference in the rate of infection between patients receiving preoperative antibiotics alone (1.56%) versus those receiving preoperative followed by postoperative antibiotics (1.20%, P = 0.711). The power value of 0.885 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.

CONCLUSION

Only a single dose of antibiotic administered at the time of induction of anesthesia is able to prevent post operative wound infection efficiently. It minimizes the ill effects of prolonged use of prophylactic antibiotic therapy and prevents the suppression of normal sensitive microbial flora and emergence of resistant bacteria, which is usually seen with prolonged antibiotics use it also reduces the patient's as well as the hospital's expenditure significantly.

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