National Journal of Basic Medical Sciences ORIGINAL ARTICLE Volume - III, Issue-3

A RETROSPECTIVE STUDY OF PATTERN OF ANTIMICROBIAL PROPHYLAXIS AND SURGICAL SITE INFECTION IN ABDOMINAL SURGERIES IN A TERTIARY CARE HOSPITAL

Basavaraj Bhandare[1], Satyanarayana .V[2], Jyotirmoy Adhikary[3]

Background : SSI is the third most commonly reported nosocomial infection. Appropriate AMP has been found to be effective in reducing SSI , but inappropriate use is associated with increase in the cost and emergence of bacterial resistance.

Aim: This study was aimed to determine the pattern of prophylactic antimicrobial utilization and incidence of SSI in abdominal surgeries .

Settings and Design: This retrospective observational study included patients who had undergone abdominal surgeries in the Department of General Surgery and Obstetrics and Gyaenacology over a period 10 months.

Material and methods : 500 abdominal surgeries were considered for study and data collected includes : types of surgeries ; wound classes ; choice, dose, route, timing and duration of AMP apart from demographic profile of the patients.

Statistical Analysis: Chi-square test was applied at 5% level of significance.

Results : In our study overall SSI rate was 12.4 %. Two drug combination of Cefotaxim and Metronidazole was most commonly used antibiotic (49.2 %). A significant statistical correlation was found between timing of AMP and SSI rate ($P < 0.05$, $\chi^2 = 5.5$). But no statistically significant correlation was found between duration of AMP and SSI ($P > 0.05$, $\chi^2 = 0.1182$).

Conclusion : As inappropriate use of antimicrobials is a significant factor for development of bacterial resistance, therefore judicious use of prophylactic antimicrobials with respect to choice, dose, route, time and duration is very essential.

Key words : Surgical site infection (SSI), Antimicrobial prophylaxis (AMP), Abdominal surgery.

INTRODUCTION

Surgical site infection (SSI) is defined as those infections presenting up to 30 days after a surgical procedure if no prosthetic is placed and up to 1 year if a prosthetic is implanted in the patient. [1]

SSI have been responsible for the increasing cost, morbidity and mortality related to surgical operations and continue to be a major problem even in hospitals with most modern facilities and standard protocols . [2]

Appropriate antimicrobial prophylaxis has been shown to be effective in reducing SSI ; but inappropriate use of antimicrobial is associated with increase in the cost of therapy and most importantly the emergence of bacterial resistance . [3]

In India, due to lack of adequate information and guidelines for antimicrobial prophylaxis in surgery there is an urgent need to generate baseline data on the pattern of use of prophylactic antimicrobials. The aim of this study was to determine the pattern of prophylactic antimicrobial utilization and incidence of SSI in abdominal surgeries in a tertiary care hospital.

MATERIALS AND METHODS

This retrospective observational study was done at Rajarajeshwari Medical College and Hospital , Bangalore . A total of 500 abdominal surgeries conducted in the Department of General Surgery and Obstetrics and Gynecology over a period 10 months (from October 2010 to July 2011) were considered for the study . Ethical clearance was obtained from the Institutional Ethical Committee of our institution before the start of the study. All surgeries where abdominal wall was opened including appendicectomy , caesarean section, abdominal hysterectomy etc were considered for the study. Those patients who were already receiving

[1]Professor & HOD, [2]Professor, [3]Post Graduate, Department of Pharmacology, Rajarajeswari Medical College & Hospital, Bangalore.

antimicrobials for therapeutic purpose were excluded from the study.

Wound infection was diagnosed if any one of the following criteria were fulfilled: pus discharge from the wound ; serous or non-purulent discharge from the wound with signs of inflammation (oedema, redness, raised local temperature, fever > 38°C, tenderness, induration) and wound deliberately opened up by the surgeon due to localized collection (serous/purulent). Stitch abscesses were excluded from this study .[3]

Wound class was considered as clean, clean contaminated, contaminated and dirty as per National Research Council classification criteria; This classification is based on the extent of intraoperative contamination[4]. Timing of administration of first dose of prophylactic antimicrobial was considered '*early operative*' if it was given more than 2 hours before incision, '*pre-operative* ' if it was given less than 2 hours before incision, ' *peri-operative* ' if it was during surgery and 'post-operative' if it was given after the completion of surgery.

The data collected includes types of surgeries, the wound classes, choice of antimicrobial prophylaxis, timing of first dose of antimicrobial prophylaxis before incision, dose and route of antimicrobial prophylaxis and duration of antimicrobial prophylaxis apart from demographic profile of the patient.

The SSI rate was analysed as per types of surgeries, the wound classes, timing of first dose and duration of antimicrobial prophylaxis.

Statistical Analysis: Chi-square test was applied to detect the statistical significance between the variables and the level of significance was set at 5%.

RESULTS

A total of 500 abdominal surgeries were screened for the study. In our study 12 different abdominal surgical procedures were performed out of which caesarean section, hernioplasty and appendicectomy accounted for 63.8 % of cases [Table 1].

The total no of SSI cases was found to be 62 and the SSI rate was 12.4 %. Out of 62 wound infections, caesarean section and appendicectomy accounted for 34 cases (55 %).

The SSI according to their wound class were recorded [Table 2]. By applying Chi-square test, a highly significant statistical correlation was found between type of wounds and SSI rate ($P < 0.001$, $\chi^2 = 36.5$).

A total no of 7 different antimicrobial agents were prescribed in our study - Cefotaxim, Cefixime, Metronidazole, Amikacin, Ciprofloxacin, fixed drug combination of Cefoprazone and Sulbactum, fixed drug combination of Amoxicilline and Clavulanic acid (Co-Amoxiclav). All the drugs were used in standard therapeutic dosage and route. A 12 different combinations of antimicrobials were used in our study where single drug was received by 6.6 % patients, 2 drug combination was received by 53.2%, 3 drug combination was received by 32.8 %, 4 drug combination was received by 7% and 6 drug combination was received by 0.4%. Amongst these, Cefotaxim and Metronidazole combination was most commonly used (49.2%) followed by 3 drug combination of Cefoperazone, Sulbactum and Metronidazole (22.2 %). [Table 3].

SSI according to timing of first dose of antimicrobial were recorded [Table 4] . It was found that out of 500 cases , 42 cases (8.4 %) had received first dose of prophylactic antimicrobial early -operatively i.e. before 2 hrs of surgical incision and 458 cases (91.6 %) received pre operatively i.e. within 2 hrs of incision . No prophylactic antimicrobial was given intra operatively or post operatively. By applying Chi-square test , a significant statistical correlation was found between timing of anti microbial prophylaxis and SSI rate ($P < 0.05$, $\chi^2 = 5.5$) [Table 4].

SSI according to duration of prophylactic antimicrobial was also recorded . [Table 5] It was found that 241 (48.2%) patients had got antimicrobial prophylaxis for more than 7 days and maximum up to 10 days in 50 cases (10 %). No statistically significant correlation was found between duration of antimicrobial prophylaxis and SSI ($P > 0.05$ $\chi^2 = 0.1182$).

[Table 1] : Surgical Site Infection according to surgical procedure		
Surgical Procedure	**No of patients n= 500 (%)**	**No of wound Infections n= 62 (%)**
LSCS	153 (30.6%)	19 (12.4%)
Hernioplasty	92 (18.4%)	4 (4.3%)
Appendicectomy	74 (14.8%)	15 (20.2%)
Abdominal Hysterectomy	54 (10.8%)	6 (11.1%)
Abdominal Tubectomy	43 (8.6%)	1 (2.3%)
Cholecystectomy	35 (7 .0%)	8 (22.8%)
Laparoscopic Tubal Occlusion	20 (4.0%)	1 (5%)
Incisional Hernia Repair	11 (2.2%)	1(9.0%)
Closure of Intestinal Perforation	6 (1.2%)	3 (50%)
Herniotomy	5 (1.0%)	0 (0%)
Intestinal Resection and Anastomosis	4 (0.8%)	3 (75%)
Exploratory laparotomy	3 (0.6%)	1 (33.3%)

[Table 2] : Surgical Site Infection according to wound class :		
Wound class	No of patients n = 500 (%)	No of wound infections n = 62 (%)
Clean	171 (34.2 %)	7 (4 %)
Clean contaminated	245 (49 .0 %)	34 (13.8 %)
Contaminated	74 (14.8 %)	15 (20.2 %)
Dirty	10 (2.0 %)	6 (60 %)
*** P <0.001 , highly significant (χ^2 = 36.50)**		

[Table 3] : Choice of Antimicrobial agents used for surgical prophylaxis			
Drug combination	No of patients (%)	Most common combination	No of patients (%)
Single drug	33 (6.6 %)	CTX	31 (6.2 %)
Two drug combination	266 (53.2 %)	CTX + MET	246 (49.2 %)
Three drug combination	164 (32.8 %)	CFP + SUL + MET	111 (22.2%)
Four drug combination	35 (7.0 %)	AMX + CLV + CFP + SUL	41 (4.2%)
Six drug combination	2 (0.4)	AMX + CLV + CFP + SUL + MET + AMK	2 (0.4)
* CTX = Cefotaxime , MET = Metronidazole , CFP = Cefoperazone , SUL = Sulbactum, AMX = Amoxicilline , CLV = Clavulanic acid , AMK = Amikacin			

DISCUSSION

The etiology of surgical site infections is dependent on the location of the surgery, the bacterial load in the tissue or blood peri-operatively and the integrity of host defenses. [5] Surgical site infections are commonest hospital acquired infections. The overall infection rate is around 2-5% for extra abdominal and about 20% for intra abdominal surgeries but varies from surgeon to surgeon, hospital to hospital, one procedure to another and even from one patient to another patient . [5]

[Table 4] Surgical site infection according to timing of prophylaxis :		
Timing	No of patients n = 500 (%)	No of wound n = 62 (%)
Early operative	42 (8.4%)	10 (23.8 %)
Pre operative	458 (91.6 %)	52 (11.3 %)
Intra- operative	Nil	Nil
Post operative	Nil	Nil
*** P < 0.05 , significant (χ^2 = 5.5186)**		

[Table 5] Surgical site infection according to duration of prophylaxis		
Duration (Days)	No of patients n= 500 (%)	No of wound infections n= 62 (%)
Less than equal to 3 days	23 (4.6 %)	3 (13 %)
Between 3 to 7 days	236 (47.2 %)	28 (11.8 %)
More than 7 days	241 (48.2 %)	31 (12.8 %)
***P > 0.05 , so not significant (χ^2 = 0.11816)**		

In our study, the overall surgical wound infection rate was 12.4 %. Many studies from India at different places have shown the SSI rate to vary from 6.09% to 38.7% . [6,7,8,9]

The infection rate in Indian hospitals is much higher than that in other countries; for instance in the USA, it is 2.8% and it is 2-5% in European countries. [6] The higher infection rate in Indian hospitals may be due to the poor set up of our hospitals and also due to the lack of attention towards the basic infection control measures.

In our study surgical site infection rate was increased from clean to dirty wound. Similar results were observed in other studies also . [10,11,12]

Prophylactic antimicrobials have been documented to be of considerable value in reducing the incidence of wound infection in several areas of surgery. At present, prophylactic antimicrobial therapy is indicated whenever : (1) the consequences of wound infection are uniformly disastrous, even though the occurrence of this sepsis is uncommon; (2) the incidence of wound infection is great,

yet seldom does it ever threaten life or limb ; and (3) the patient has such an extreme impairment in host defense mechanisms .[13]

But Inappropriate use of antimicrobial is associated with unnecessary increase in the cost of therapy and in the emergence of drug resistant bacteria.[14]

According to American Society of Health System Pharmacist (ASHP) guidelines [15] an anti-infective drug should be active against the pathogens most likely to contaminate the wound and should be given in an appropriate dosage and at a time that ensures adequate concentrations at the incision site during the period of potential contamination; it should be safe and administered for the shortest effective period to minimize adverse effects, development of resistance, and cost [15] . As per ASHP guidelines, Cefazolin (first-generation cephalosporin), Cefuroxime and Cefoxitin (2nd generation Cephalosporins) have been widely recommended for antimicrobial prophylaxis for surgeries. But third generation Cephalosporins, such as Cefotaxime, Cefoperazone, Ceftriaxone etc are generally not recommended for surgical prophylaxis as it is associated with development of drug resistant organisms[16].

But in case of already established infection as per Surgical Infection Society (SIS) guidelines [17] , third/ fourth generation Cephalosporin plus an anti-anaerobic (Clindamycin or Metronidazole), Aminoglycoside plus an antianaerobic are also very effective . However, no regimen has been found to be superior to the other[18].

In our study we have found that 3rd generation Cephalosporins (Cefotaxime and Cefoperazone) along with combination of Metronidazole are commonly used antimicrobial combination . This combination was found to be given in even clean surgeries like hernioplasty , tubal occlusion etc where no signs of infection was present and this was found to be irrational as per different standard guidelines like ASHP [15] and SIGN (Scottish Intercollegiate Guidelines Networks) [19] because of the emergence of drug resistant organisms .

Similar results had been found in a study conducted by Kulkarni et.al [20] to see the patterns of antimicrobial use by surgeons in India . They found that a third / fourth generation Cephalosporin along with an anti- anaerobic agent was the most preferred antimicrobial combination (84%).

Timing of administration first dose of antimicrobial prophylaxis is very important . The pre operative antibiotic prophylaxis can decrease post-operative morbidity, shorten the hospital stay and it could also reduce the overall cost which were attributable to the infection .[21]

In our study we found that the administration of first dose of antimicrobial prophylaxis longer than 2 hours prior to surgery was confirmed to be associated with a higher SSI rate [Table 5] . Similar observations were made by study done by Platon E M et al .[22] According to ASHP [15] guidelines the drug should be administered ideally within 30 to 60 minutes and certainly within 2 hours of the time of incision. For longer procedures, readministration of the drug is indicated at intervals of one or two times the half-life of the drug (using the same dose).[23] This ensures adequate tissue levels throughout the duration of the procedure. The duration of an adequate tissue level of the antibiotic need not exceed the operative period.

Now according to ASHP guidelines[15], duration of antimicrobial prophylaxis should be 24 hr or less with the exception of cardiothoracic procedure (up to 72 hrs duration). In abdominal surgeries, according to SIS guidelines [17], duration should be less than or equal to 24 hrs in those patients who do not have any sign of established intra-abdominal infections. But patients with established infections should be treated with therapeutic antimicrobials for more than 24 hrs but should be limited to not more than 7 days. The duration of antimicrobial therapy for intra-abdominal infections can be based on the intra-operative findings at the time of initial intervention. Antimicrobial therapy can be discontinued in patients when they have no clinical evidence of infection such as fever or leukocytosis.[17]

In our study we have found that 241 (48 . 2 %) patients had got antimicrobial prophylaxis for more than 7 days and maximum up to 10 days in 50 cases (10 %) which is

found to be irrational as per different standard guidelines like SIGN [19], ASHP [15] and SIS guidelines [17].

The disadvantages in continuing prophylaxis for long duration are (1) increase in cost of prophylaxis, (2) increase stay in hospital and more importantly (3) the development of drug resistant organisms which is one of the most serious threat to global public health and it is growing at an alarming pace, perhaps more rapidly in developing countries like India .

Although prophylactic antimicrobials play an important part in reducing the rate of postoperative wound infection, other factors, such as the surgeon's experience, the length of the procedure, hospital and operating-room environments, and the underlying medical condition of the patient, have a strong impact on wound infection rates.

A sound antibiotic policy, reduction of length of procedures through adequate training of the staff on proper surgical techniques, proper intra-operative infection control measures and feedback of appropriate data to surgeons regarding SSIs would be desirable to reduce the surgical site infection rate . [15]

Prevention of surgical site infection remains the basic concern of the surgeon and prophylactic antibiotics are frequently used to prevent these potential infections. Adequate prevention of such infections is important because they are associated with increased morbidity , mortality and hospital costs .The fear of morbidity and mortality associated with Surgical Site Infections (SSI) has lead to high usage of antimicrobials in the peri-operative period. Despite recommendations and guidelines formulated by various surgical committees regarding appropriate use of antimicrobials, these are rarely implemented in practice. Hence various forms of inappropriate prescribing often remain unnoticed. This is because of lack of an active Hospital Infection Control Committee (HICC) or established Institutional guidelines to streamline the antimicrobial prescribing practices.

There were some drawbacks of our study. Since our study was a retrospective study, it included SSIs which occurred within the hospital and cases which might have developed SSI after discharge within 30 days were not included as post discharge surveillance of wound infection was not done in our hospital. So a prospective study with post discharge surveillance up to 30 days would yield more information. Also as it was a single center study it has got some limitations. So a large multicenter study would help to generate a baseline data on prophylactic use of antimicrobials, which will be beneficial to the surgeons for better guidance and rational administration of antimicrobial prophylaxis.

CONCLUSION

Assessment of current antimicrobial prescribing patterns is an important step towards promoting appropriate use of antimicrobial agents . This study was done to assess the prescribing pattern of antimicrobial prophylaxis along with surgical site infection in our institute . In our setup there was proper adherence to standard guidelines for dose , route and timing of antimicrobial prophylaxis but choice and duration of antimicrobial prophylaxis had to be reconsidered as per different standard guidelines . Inappropriate use of antimicrobials including over prescription and unnecessary use of broad-spectrum antibiotics is recognized as a significant contributing factor to the development and spread of bacterial resistance which has led to situations where no suitable antimicrobials will be available in future to combat serious infections. Therefore, judicious use of prophylactic antimicrobials with respect to choice , time and duration is very essential to minimize the antibiotic resistance and prevent surgical site infections. Also institutional antibiotic policy and wound surveillance cell would go a long way in minimizing SSI and bacterial resistance.

REFERENCE

1. Awad SS, Palacio CH, Subramanian A. , et al . Implementation of a methicillin-resistant Staphylococcus aureus (MRSA) prevention bundle results in decreased MRSA surgical site infections. ***Am J Surg* . 2009** ; 198 (5) : 607-610.
2. Yalcin AN, Bakir M, Bakici Z, Dokmetas I, Sabir N . Postoperative wound infections. J. Hosp. Infect. 1995 ; 29 (4) : 305-309
3. Nichols RL. Preventing surgical site infections: A surgeon's perspective. *Emerg Infect Dis* 2001; **7(2):** 220–224.
4. Ercole FF, Starling CEF, Chianca TCM, Carneiro M. Applicability of the National Nosocomial Infections Surveillance System Risk Index for the

Prediction of Surgical Site Infections: A Review. *The Brazilian Journal of Infectious Diseases.* 2007; 11(1):134-41

5. Liu SA, Chiu YT, Lin WD, Chen SJ. Using information technology to reduce the inappropriate use of surgical prophylactic antibiotic. *Eur Arch Otorhinolaryngol*. 2008 ;265(9):1109-12.
6. Mahesh C B, Shivakumar S, Suresh BS, Chidanand SP, Vishwanath Y. A prospective study of surgical site infections in a teaching hospital. *Journal of Clinical and Diagnostic Research* 2010 ; 4 :3114-3119.
7. Lilani SP, Jangale N, Chowdhary A, Daver GB. Surgical site infection in clean and clean-contaminated cases. *Indian J Med Microbiol* .2005; 23 (4) :249-52.
8. Anvikar AR, Deshmukh AB, Karyakarte RP, Damle AS, Patwardhan NS, Malik AK, *et al* . A one year prospective study of 3,280 surgical wounds. *Indian J Med Microbiol* 1999; 17 (3) :129-32.
9. Ganguly. PS, Khan Y. Malik A. Nosocomial infection and hospital procedures. *Indian J. common Med*.2000; 25 (1) : 990-1014.
10. Nandi PL, Rajan SS, Mak KC, Chan SC, So YP. Surgical wound infection. *HKMJ.* 1999; 5: 82-86.
11. Krukowski Z H, Stewart M P M, Alsayer H M, Matheson N A. Infection after abdominal surgery: Five year prospective study. *British Medical Journal.* 1984; 288 (6413) :278-80.
12. Kamat US, Fereirra AMA, Kulkarni MS, Motghare DD. A prospective study of surgical site infections in a teaching hospital in Goa. *Indian J Surg* . 2008; 70 (3) :120-124.
13. Yohannes Y, Mengesha Y, Tewelde Y. Timing, choice and duration of peri-operative prophylactic antibiotic use in surgery: A teaching hospital based experience from Eritrea, in 2009. *Journal of Eritrean Medical Association* 2009 ; 4 (1) : 65-67.
14. Nichols RL. Preventing surgical site infections: A surgeon's perspective. *Emerg Infect Dis* 2001; **7(2):** 220–224.
15. American Society of Health System Pharmacists. The ASHP therapeutic guidelines on antimicrobial prophylaxis insurgery.1999 Available from URL:http://www.ashp.org/DocLibrary/BestPractices/TG_Surgical.aspx [cited 2012 April 10].
16. Heineck I, Ferreira MBC, Schenkel EP. Prescribing practice for antibiotic prophylaxis for 3 commonly performed surgeries in a teaching hospital in Brazil. *Am J Infect Control.* 1999; **27:** 296-300.
17. Mazuski JE, Sawyer RG, Nathens AB, Dipiro JT, Schein M, Kudsk KA, et al. The Surgical Infection Society Guidelines on Antimicrobial Therapy for Intra-Abdominal Infections: An Executive Summary. *Surg Infect* . 2002;3:161–173.
18. Solomkin JS, Mazuski JE, Baron EJ, Sawyer RG, Nathens AB, DiPiro JT, et al. Guidelines for the Selection of Anti-infective Agents for Complicated Intra-abdominal Infections. IDSA Guidelines. *Clin Infect Dis* . 2003;37:997–1005.
19. Scottish Intercollegiate Guidelines Network. Antibiotic prophylaxis in surgery. 2008. Available from URL: http:// www.sign.ac.uk/pdf/sign104.pdf [cited 2012 April 10] .
20. Kulkarni R. A., Kochhar P. H., Dargude V. A.,et al. Patterns of antimicrobial use by surgeons in India . *Indian J Surg* . 2005 ; 67 (6) : 308 – 315 .
21. Haley RW, Schaberg DR, Crossley KB, Von Allmen SD, Mac Gowan JE. Extra charges and prolongation of stay attributable to nosocomial infections: a prospective interhospital comparison . *Am J Med* .1981; 70:51-8.
22. Platon E M, Antolin JAJ, Zubiqaray S, Garcia PB. The effect of surgical antibiotic prophylaxis and the timing of its administration on the risk of surgical wound infection. *Rev Clin Esp*.1995 Oct; 195(10):669-73.
23. Nichols RL. Surgical antibiotic prophylaxis. *Med Clin North Am.* 1995; 79:509-22.