JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH

ORIGINAL ARTICLE

A Prospective Study Of Surgical Site Infections In A Teaching Hospital

MAHESH C B*, SHIVAKUMAR S, SURESH B S***, CHIDANAND S P****, VISHWANATH Y*****

ABSTRACT

Context: Surgical site infections (SSI) remain a significant problem following an operation and the third most frequently reported nosocomial infections. **Aim:** The current study was undertaken to identify aerobic pathogenic bacteria in SSI, to determine their antibiotic resistance pattern and to study the factors influencing SSI. **Material and Methods:** The prospective study was carried out on 418 surgeries. Samples from patients were collected by following all aseptic precautions and were processed without delay by the standard microbiological techniques. Chi square test was used for statistical analysis. **Results and Conclusions:** The overall infection rate was 20.09%. The SSI rate was 11.53% in clean surgeries, 23.33% in clean contaminated ones, 38.10% in contaminated ones and 57.14% in dirty surgeries. Male patients were affected more (21%) than the female patients (18.88%). The SSI rate increased with increasing age and it also increased significantly with the increasing duration of pre-operative hospitalization. The SSI rate was significantly less in patients who received pre-operative antibiotic prophylaxis. The SSI rate was significantly higher in emergency surgeries as compared to the elective surgeries. The infection rate was significantly higher as the order and the duration of the surgery increased. The most commonly isolated organism from surgical site infections was *Staphylococcus aureus* (34.44%), followed by *Pseudomonas aerogenosa* (26.22%) and other bacteria. Most of the organisms which were isolated were multidrug resistant. The high rate of resistance to many antibiotics underscored the need for a policy that could promote a more rational use of antibiotics.

Key Messages:

1.SSIs still remain one of the most important causes of morbidity and mortality in surgically treated patients.
2.There are various factors which influence SSI.
3.The steps taken to reduce SSI are still not adequate.
4.Proper infection control measures and a sound antibiotic policy should reduce SSI in the future.

Key words: Factors influencing SSI. , *Pseudomonas aerogenosa*, *Staphylococcus aureus*, Surgical site infections.

*M D, Assistant Professor, S N M C Bagalkot, **M D, Asso Professor, S N M C Bagalkot, ***M D, Asst Professor, S N M C Bagalkot, ****M D, Principal, S N Medical college, Bagalkot, *****M D, Professor and HOD, Dept of microbiology, S N M C Bagalkot.
Corresponding Author AND guarantor:
Dr. Mahesh C B, MD
Assistant professor,
Dept. of microbiology,
S. N. Medical college,
Bagalkot- 587101
Karnataka.
Ph:9945471374
Mail-baragundimc@rediffmail.com

Introduction

Despite the advances made in asepsis, antimicrobial drugs, sterilization and operative techniques, surgical site infections (SSI) continue to be a major problem in all branches of surgery in the hospitals.[1] Based on the National Nosocomial Infections Surveillance, SSIs are the third most frequently reported nosocomial infections, accounting for 14-16% of all the nosocomial infections.[2] SSIs are responsible for the increasing costs and the morbidity and mortality which are related to surgical infections.[3] The organisms which cause surgical infections vary from time to time and from place to place.[2] The pathogens that infect surgical wounds can be a part of the patient's normal flora or they may be acquired from the hospital environment.[4] The objective of the study was to know the rate of surgical site infections, to determine the frequencies of various pathogens causing SSI with their antibiotic resistance patterns and to study the factors which influence SSI.

Materials And Methods

The present study was conducted between July 2007 to August -2009. The ethical standards for human experimentation were followed during the study and permission from the institutional ethical committee was taken.

The CDC criteria were used for defining the type of surgical wounds.[5]

Class-I / Clean: An uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital, or uninfected urinary tract is not entered. In addition, clean wounds are primarily closed and if necessary, drained with closed drainage.

Class-II / Clean contaminated: An operative wound in which the respiratory, alimentary, genital or urinary tracts are entered under controlled conditions and without unusual contamination.

Class III /Contaminated: Open, fresh, accidental wounds. In addition, operations with major breaks in sterile techniques or gross spillage from the GIT and incisions in which acute, non-purulent inflammations are encountered.

Class-IV / Dirty: Old traumatic wounds with retained devitalized tissues and those that involve the existing clinical infection or perforated viscera.

CDC's NNIS (National Nosocomial Infection Surveillance) System was used for defining SSIs.[6] According to this system, the infection was considered to be an SSI, if the infection occurred within 30 days after the operation or within 1 year if the implant was in place and the infection appeared to be related to the operation. Stitch abscess was not included under SSIs.

A detailed history regarding pre operative stay, antibiotic therapy, the type of surgery and the nature (elective/ emergency), order and the duration of the operation was taken. Samples in the form of swabs were collected aseptically from the wounds at the time of the first dressing, anytime up to 30 days from the wounds giving serous, purulent discharge, showing signs of inflammation, or from wounds that dehisced spontaneously.

All the samples were processed aerobically (anaerobic culture was not included in the study) as early as possible, by using standard microbiological techniques.[7] The samples were cultured on Blood agar and MacConkey's agar. The isolates were identified by routine biochemical tests and antimicrobial susceptibility testing was done by the Kirby-Bauer disc diffusion method.

The data was statistically analyzed by the Chi-square test .P values were calculated by using the EPI INFO 2002 software from CDC.

Results

A total of 418 surgical wounds were included in the study. The overall infection rate was 20.09%. The infection rates in different types of surgeries are shown in [Table/Fig 1]. The number of infected cases was 30(11.53%) in clean surgeries, 14 (23.33%) in clean contaminated ones, 32 (38.09%) in contaminated ones and 8 (57.14%) in dirty surgeries. The difference in the rate of infection in different surgeries was analyzed statistically and was found to be significant (p=0.000000<)

[Table/Fig 1]: Analysis of infection rate related to type of surgery

Type of Surgery	Number of infected cases	Percentage	Number of cases not infected	Percentage	Total
Clean	30	11.53	230	88.47	260
Clean Contaminated	14	23.33	46	76.67	60
Contaminated	32	38.09	52	61.91	84
Dirty	08	57.14	06	42.86	14
Total	84	20.09	334	79.91	418

X^2cal = 41.16, X^2 tab =16.27. P=0.000000<.

50/238(21%) males and 34/180(18.88%) females were infected.

18/96 (18.75%) patients in the age group of 0-10 yrs were infected. Similarly, 8/62(12.90%) patients in the age group of 11-20 yrs, 8/50(16%) patients in the age group of 21-30 yrs, 6/58(10.34%) patients in the age group of 31-40 yrs, 14/46(30.43%) patients in the age group of 41-50 yrs, 10/58(17.24%) patients in the age group of 51-60 yrs, 6/18(33.33%) patients in the age group of 61-70 yrs and 14/30(46.66%) patients in the age group of >70 yrs were infected. The age wise distribution of SSIs showed a higher infection rate in the age group of more than 60 years.

SSIs were seen in 34(13.93%) cases where pre-operative hospitalization was for one day, in 32(28.57%) cases where pre-operative hospitalization was for 1 day to 1 week and in 8(33.33%) cases where pre-operative hospitalization was for more than 1 week. As the duration of the pre-operative stay increased, the rate of SSIs also increased. The difference in the rate of infection was analyzed statistically and was found to be significant (p=0.00109)

SSIs were seen in14 (20%) patients who had not received pre operative antibiotic therapy and in 16(8.42%) cases in patients who had received pre operative antibiotic therapy. The difference in the rate of infection was found to be significant (p=0.0095)

[Table/Fig 2] shows the infection rate in elective and emergency surgeries. SSIs were present in as high as 16(21.05%) cases in emergency surgeries as compared to their presence in 14(7.61%) cases in elective surgeries. The difference in the rate of infection was analyzed statistically and it was found to be significant (p=0.002)

[Table/Fig 2]Infection rate in elective and emergency clean surgeries.

Type of Surgery	Number of cases infected	percentage	Number of cases not infected	Percentage	Total
Elective	14	7.61	170	92.39	184
Emergency	16	21.05	60	78.95	76
Total	30	11.54	230	88.45	260

X^2 cal = 9.52, X^2 tab = 6.64, P=0.002.

The infection rate with respect to the order of the surgery and the duration of surgery is shown in [Table/Figs 3] and [Table/Figs 4] respectively. The rate of SSIs increased as the order and the duration of the surgeries increased. The difference in the rate of infection was statistically significant (p=0.0017 and p=0.018)

[Table/Fig 3]: Infection rate related to order of operation in O.T in clean surgeries

Order of operation in O.T	Number of cases infected	Percentage	Number of cases not infected	Percentage	Total
First	06	05	114	95	120
Second	06	10	54	90	60
Third	08	20	32	80	40
Fourth	10	25	30	75	40
Total	30	11.53	230	88.47	260

X^2 cal = 15.07, X^2 tab = 11.34, P=0.0017.

[Table/Fig 4]: Infection rate related to duration of Surgery in clean Surgeries

Duration	Number of cases infected	Percentage	Number of cases not infected	Percentage	Total
0-1 hours	14	8.75	146	91.25	160
1-2 hours	08	11.42	62	88.58	70
2 hours & more	08	26.66	22	73.34	30
Total	30	11.53	230	88.47	260

X^2 cal = 7.95, X^2 tab = 7.82, P = 0.018.

A total of 122 isolates were obtained out of 84 infected wounds. 30 cases showed the growth of 2 pathogens and 8 cases showed the growth of 3 pathogens. 42(34.44%) *Staphylococcus aureus* were isolated. This was the most frequent pathogen which was followed by 32(26.22%) *P .aerogenosa*, 18(14.72%) *E.coli*, 8(6.55%) *P.mirabilis*, 6(4.91%) *K.pneumoniae*, 4(3.27%) *S.epidermidis*, 4(3.27%) *Enterobacter sps*, 4(3.27%) *Non fermenting gram negative bacilli* and 4(3.27%) *Enterococcus sps.*

Most of the isolates were multidrug resistant. [Table/Fig 5] shows the drug resistance pattern of different isolates.

[Table/Fig 5]: Antibiotic Resistance pattern of different Isolates

S.N	Organism (No. of isolates)	Antibiotic (percentage of isolates Resistant to antibiotic)
1	*Staphylococcus aureus(42)*	P(80.95),ox(83.33),Va(0),CD(28.57),AT(28.57),Co(78.57) G(66.66), Cf(61.90),C(64.28),T(69.04),LZ(0).
2	*Pseudomonas aerogenosa(32)*	TI(68.75),G(78.12),CA(34.37),Cs(62.50),AK(46.87), Cf(78.12),Co(87.50),Ce(59.37),C(81.25).
3	*E.coli(18)*	A(77.77),Cz(72.22),G(38.88), TI(66.66),AC(38.88),Cs(44.44) Ak(33.33),Cf(61.15),Co(88.88) CA(22.22) C(44.44),T(66.67)
4	*Proteus mirabilis(8)*	A(87.50),Cz(75),G(75),TI(75),Ac(50), Cs(62.50),AK(37.50) Cf(75), Co(87.50), CA(50),C(62.50),T(75)
5	*Klebsiella pneumoniae(6)*	A(83.33),CZ(50),G(83.33),TI(66.67), Ac(50).Cs(83.33), AK(33.33), Cf(83.33), Co(83.33),Ca(100), C(50), T(33.33)
6	*Staphylococcus Epidermidis(4)*	P(75), Ox(75),Va(0),CD(50),Co(100), G(75),Cf(75), C(25), T(50), LZ(0),AT(50)
7	*Enterobacter sps(4)*	A(100), CZ(100),G(75),TI(50),Ac(0), Cs(75),AK(50),Cf(25) Co(50),CA(50),C(50),T(75)
8	*Non-formenting gram negative bacilli(4)*	TI(50),G(50),CA(50),Cs(25),AK(100),Cf(50),Co(50),Ce(50)C(75)
9	*Enterococcus(4)*	A(75),Va(0),AT(50),Co(100),G(50),Cf(50),C(75),T(75), Cz(75),AK(25).

P-Pencillin G, Ox-Oxacillin, Va-Vancomycin. CD-Clindamycin, AT-Azithromycin, Co-Co.Trimoxazole, G-Gentamycin, Cf-Ciprofloxacin, C-Chloramphenicol, T-Tetracycline, Lz-Lenezolid, TI-Ticarcillin, CA-Ceftazidime, Cs-Cefoperazone, AK-Amikacin, Ce-Cephotaxime, A-Ampicillin, Cz-Cefazolin, Ac-Amoxycillin& clavulinic acid,Cs-Cefoperazone

Discussion

The overall infection rate for a total of the 418 cases was 20.09%. Different studies from India at different places have shown the SSI rate to vary from 6.09% to 38.7 %.[1],[3],[8],[9],[10],[11]. 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.[12] 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.

There was increase in rate of SSIs from clean to dirty surgeries. Similar results were observed in other studies also. [9],[13],[14],[15]. Our study showed a high infection rate in clean surgeries. It could be due to the poor patients who attended our hospital, who failed to take proper care of their post operative wounds. They would get discharged early, would fail to take the prescribed antibiotics and would return back with the infected wounds. The results were statistically analyzed and it was found that there existed a significant difference in the rate of SSIs in different types of surgeries (p=0.0000<). The difference in the rates of SSIs between the clean and the clean contaminated wounds showed the effect of endogenous contamination and the difference in the rates of SSIs between the clean contaminated and the dirty wounds showed the effect of exogenous contamination. The endogenous or the exogenous contamination of the wounds by the organisms had a profound influence on the SSIs.

The rates of SSIs in male patients were 21% and in female patients, they were 18.88%. The significance of this observation is not well understood. The infection rate was found to increase with an increase in age.[1],[9],[16] This could be due to the deteriorating immune status and the associated illness in old aged patients.

The rates of SSIs increased with the increasing duration of pre operative hospitalization. The P value was 0.00109, thus indicating that the difference in the infection rates was significant. The higher incidence of infections due to a longer stay in the hospital could be attributed to the increased colonization of patients with nosocomial strains in the hospital [17],[18] and also, a longer pre-operative stay in the hospital reflected the severity of the illness and the co-morbid conditions which required patient work- up and or therapy before the operation.[19],[20],[21]

The pre operative antibiotic prophylaxis reduced the rate of SSIs from 20% to 8.42%. The difference was statistically significant (p=0.0095). Contrary to the results of our study, a higher SSI rate in patients who had received pre operative antibiotics, was observed by P.K. Agarwal *et al*.[17] Antibiotic prophylaxis reduced the microbial burden of the intra operative contamination to a level that could not overwhelm the host defenses. The pre operative antibiotic prophylaxis could decrease post operative morbidity, shorten the hospital stay and it could also reduce the overall costs which were attributable to the infection.[22]

The SSI rate in elective surgeries was found to be 7.61%, which was found to increase to 21.05% in emergency cases. The difference was statistically significant (p=0.002).Our results are comparable well with the results obtained by other workers [3],[9],[17] The high rates of infection in emergency surgeries can be attributed to inadequate pre operative preparation, the underlying conditions which predisposed to the emergency surgery and the more frequency of contaminated or dirty wounds in emergency surgeries.

A statistically significant association was observed between the rate of SSIs, the order of the operation (number of the particular operation in the OT list on that day) and the duration of the operation. As the order and the duration of the operation increased, the rate of SSIs also increased. The factors which were incriminated were the onset of fatigue, resulting in a decline of aseptic measures and an increase in pollution in the operation theater with the lapse of time[10], as more contaminated operations were performed towards the end of the operation session for the fear of contaminating the O.T early during the day.[9]

A total of 122 organisms were isolated from 84 infected patients. 3 different isolates were grown from 8 patients, 2 different isolates were grown from 30 patients and one isolate was obtained from 46 patients. This indicates that many times, the surgical wound is infected by more than one organism. *Staphylococcus aureus* (34.44%) was the most commonly isolated organism, followed by *P.aeroginosa* (26.22%) and others. *Staphylococcus aureus* was the most common organism which was isolated from SSIs by Sampson [23] and Prabhakar et al [24].*Klebsiella pneumoniae* (26.80%) was reported as most common isolate from SSIs by Anvikar *etal*,[3] *E.coli* was reported by P.K Agarwal *et a*l,[2] and *Pseudomonas* by Umesh *et al* [9] and Lateef OA *et al.*[25] . The relative frequency of different isolates also varied between different studies. Thus, it can be concluded that the organisms that cause SSIs change from place to place and from time to time in the same place.

The antibiotic sensitivity testing of different isolates showed multidrug resistance by most of the isolates. More than 80% isolates of *Staphylococcus aureus* were resistant to penicillin and oxacillin. All *Staphylococcus aureus* isolates were sensitive to linezolid and vancomycin. *Pseudomonas* was resistant to most of the drugs which were used. Drug resistance in most of the isolates for commonly used drugs was more than 50%. *Enterobacter sps* showed 100% sensitivity to amoxycillin+ clavulinic acid and though vancomycin resistant *Entercocci* are now common, our study revealed 100% sensitivity to vancomycin, may be because in our study, the number of *Enterococci* which were tested, were very few(4).

The review of literature indicates that there is gradual increase in drug resistance to many antibiotics in most of the organisms which are isolated from surgical patients.

Our study reveals that though SSIs have been widely studied since a long time, they still remain as one of the most important causes of morbidity and mortality in surgically treated patients. The steps taken to reduce SSIs are still not adequate. Proper infection control measures and a sound antibiotic policy should reduce SSIs in the future.

Aknowledgement

Department of surgery, S.N.M.C. Bagalkot- For providing the cases for the study.

Mrs Kalpana Kulkarni and Dr. Umesh.Y.Ramadurga , Dept of community medicine,S.N.M.C, Bagalkot-For statistical analysis of data.

References

[1] S. P. Linani, N Jangali, A Chowadhary, G.B. Daver. Surgical site infection in clean and clean contiaminated cases. Indain J of med Microbiol2005; 23 (4):249-252

[2] Agarwal Pradeeep kumar, Agarwal Mithelesh, Bal, Ashok Talat Halim. Epidemilology of Pseudomonas aeroginosa; post –operative wound sepsis. Indian J . Pathol Microbiol1985; 28:137- 146

[3] Anvikar A.R, Desmukh A. B, Karyakarte R.P, Damble A.S,Patvardan N S, Malik A.k et al .A one year prospective study of 3280 surgical wounds. Indian J Med Microbiol 1999; 17 (3) :129-132.

[4] Angue .J.R. , Olila D.Drug sensitivity patters of bacteria isolated from septic post – operative wounds in a regional referral

hospital in Uganda. African Health sciences 2007; 7 (3) :140-154

[5] Alicia .J. Mangram MD, Teresa. C. Horan, Michel L, Pearson Leah Chinstine, Silver, Willium R et-al. Guideline for prevention of surgical site infection. Infection control and hospital epidemiology1999;20(4):250-280.

[6] Horan TC, Gaynes RP, Mrtone WJ, Jarvis WR, Emori,TG .CDC definitions of nosocomial surgical site infections 1992: a modification of CDC definitions of surgical wound infections. Infect control Hosp Epidemiol 1992; 13{10} :606 -608

[7] Koneman EW, Allen S.D, Janda WM. Colour Atlas and Textbook of Diagnostic Microbiology 5th ed USA : Lippincott.Raven publishers. 1997.

[8] Subramanian K.A, Prkash A, Shrinvas, Bhujwal RA. post-operative wound infection. Ind J surg 1973; 57-64

[9] Umesh . S. Kamat, AMA Fereirra, M. S. Kulkarni , D.D Motghare. A prospective study of surgical site infections in a teaching hospital in Goa.Indian J Surg 2008;70:120-124.

[10] B.S. Tripathy, N. Roy. Post –operative wound sepsis. Indian. J. sur1984; 285-288.

[11] Ganguly. PS, Khan Y. Malik A. Nosocomial infection and hospital procedures. Indian J. common Med.2000

[12] Dellinger Ep, Ehrankarns NJ . Surgical infections, in hospital infection, 4th edn. Edited by bennet JV. Brachmann PS. Lippiont-Raven Publishers, Philadephia 1998.

[13] Mary olson, RN, B.S.N. Melody o' Connor, Michel L, Schwarts . A 5-Year Prospective study of 20,193 wounds at the Minneapolis V A Medical Centre. Ann. Surg 1984; 199:253-259

[14] P.L Nandi, S Souara. Rajan, KC Mak, SC Chan, YP So. Surgical wound infection. HKMJ 1999; 5 (1).

[15] Abu Hanifah Y. Post-operative surgical wound infection .Med J Malaysia 1990 ;45(4) :293-7

[16] Stephen Sixto Siguan, Bernard S Ang, Issac M. Pala and Reynaldo M, Baclig . Aerobic surgical infection : A surveillance on microbiological etiology and Antimicrobial sensitivity pattern of commonly used Antibiotics. Phil J Microbiol Infect Dis 1990;19(1):27-33.

[17] P. K. Agarwal, M. Agarwal, A Bal, Y.V.S Gahalaut. Incidence of Post-operative wound infection at Aligarh. Indian J. Surg 1986;326-332.

[18] Siguan S.S, Laudico AV. Aerobic surgical wound infection. Microbiology and antibiotic antimicrobial activity. Philipp J surg Spec1987;42(1).

[19] Cruse P J, Foord R. The epidemiology of wound infection :A 10-year prospective study of 62, 939 wounds. Surg Clin North Am 1980;60(1):27-40.

[20] Nooyen SM, Overbeek BP, Brutel de la. Rere A,Strom AJ, Langemeyer JM. Prospective randomised comparison of single dose versus multidose cefuroxime for prophylaxis in coronary artery bypass grafting. Eur clin Microbial Infect Dis 1994;13:1033-7.

[21] Brun J N. Post operative wound infection. Predisposing factors and the effect of reduction in dissemination of Staphylococci.Acta Med Scand Suppl 1970;514:3-89.

[22] Haley RW, Schaberg DR,Crossley KB,Von Allmen SD,Mac Gowan JE. Extra charges and prolongation of stay attributable to nosocomial infections; a prospective inter hospital comparision. Am J Med 1981;70:51-8.

[23] Sampson P.Post operative wound sepsis rate can be cut by simple measures. JAMA;239(1):9-10.

[24] Prabhakar H,Arora S. A bacteriological study of wound infections. J Indian Med Assoc 1979;73:145-8.

[25] Lateef OA Thanni, Olubunmi Aosinopebi,Mope Deji-Agboola. Prevalence of bacterial pathogens in infected wounds in a tertiary hospital;1995-2001: Any change in trend ?.J National Med Assoc 2003;95(12):1189-95.