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Surgical site infection in surgery ward at a tertiary care hospital: the infection rate and the bacteriological profile

Dr Nandita Pal[1*], Dr Rajyasri Guhathakurta (Mukherjee)[2]

[1*]*Assistant Professor, Department of Microbiology, Sagar Dutta Medical College and Hospital, Kolkata (W.B)*
[2]*Professor & HOD, Department of Microbiology, Midnapore Medical College, Midnapore (W.B)*

Abstract
Background: ***Surgical Site Infections (SSI) constitute a major fraction of nosocomial infections and occur in superficial incisional, deep incisional, and organ\space locations. The bacteriological profile of SSI and their antibiotic-susceptibility-pattern; aims towards planning proper treatment of SSI.***
Objectives: ***To determine the SSI rate MIS (Minimally Invasive Surgery) vs OS (Open surgery) during the study period, the bacteriological profile of SSI & their antibiotic-susceptibility-pattern, and to build up guidelines for empirical treatment of SSI till antibiotic sensitivity results are procured.***
Design: ***Prospective, randomized, hospital based study.***
Materials and Methods: ***The study included 784 patients; undergoing either OS or MIS\laparoscopic surgery from May 2009 to April 2011; at surgery department of hospital, among which; 72 cases of SSI was observed. Aspirated secretion\pus\wound swab was obtained from operation site of all the cases and cultured aerobically and an-aerobically using standard microbiological techniques. For control, skin swabs were collected from proposed incision site; prior to surgical draping; and bacterial culture attempted in all the subjects. The isolates were processed as per standard test guidelines. Antibiotic susceptibility tests were done by Kirby-Bauer technique.***
Results: ***Rate of SSI was 2.06% vs 16.16% in MIS vs OS. Most predominant pathogen was Staphylococcus aureus, predominantly Oxacillin resistant Staphylococcus aureus (ORSA-56.5%). Superficial SSIs were predominated by S.aureus. Deep SSI was predominated Klebsiella sp. ORSA were highly sensitive to vancomycin and linezolide. All ESBL producing isolates were highly sensitive to imipenem.***
Conclusions: ***Multidrugresistant (MDR) bacteria have profound role in SSIs. Empirical antibiotic therapy essentially to be started at clinicians end; before receiving the antibiotic susceptibility test results; may include therapy with amikacin and piperacillin- tazobactum or amikacin and cefoperazone- sulbactum & must be switched over to vancomycin or linezolide when ORSA is the causative agent or, to other suitable antibiotics in case of ESBL producing etiology; strictly; as directed by microbial culture and antibiotic susceptibility test report.***

Keywords—Antibiotic stewardship, Empirical antibiotic therapy, Minimally invasive surgery, Multidrugresistant bacteria, Open surgery, Oxacillin resistant Staphylococcus aureus, Surgical site infection

I. INTRODUCTION

Surgical site infections (SSIs) infections occur within thirty days after the operative procedure (except in case of added implants, when the duration extends to one year from operation). Surveillance for SSI remains a challenge exacerbated by early discharge and outpatient surgery. [1,2,3,4] The Centre for Disease Control, (CDC), USA, classifies the surgical site infections into: (a) Superficial incisional SSI which involves only skin and subcutaneous tissue of incision, (b) Deep incisional SSI which involves deep soft tissues (e.g. fascia and muscle layer) of the incision, (c) Organ \Space SSI includes infection apparently related to the operative procedure and infection involves any part of the body, excluding skin incision, fascia, muscle layer that is operated or manipulated during operative procedure.[5,6]

SSI should be diagnosed and treated appropriately to return patients to home early.[6] SSI rate of zero may not be achievable. Continued progress in understanding the biology of infection at the surgical site, knowledge of SSI associated pathogens & assessment of antibiotic sensitivity pattern is essential for appropriate treatment.

II. MATERIALS AND METHODS

The study was carried out on 784 patients with clean-contaminated post surgical wounds following open surgery\minimal invasive surgery; for two years from May 2009 to April 2011, at surgery department of a tertiary care hospital. The surgical procedures included in study were: cholecystectomy, appendisectomy, and hernioplasty. Patients were monitored at admission, 48 hrs. post-operative follow-up, 1st week, once weekly till discharge, and at four week follow-up. The inclusion criteria were according to the SSIs case definition given by The Centre for Disease Control, (CDC), USA. Wound infections other than surgical wound, stitch abscess, SSI in obstructed hernia, perforated appendicitis, and cholecystectomy following spillage were carefully excluded from the study. For control, skin swab was collected and bacterial culture attempted; from proposed incision site before surgical draping; in all the subjects. Aspirated secretion/wound swab obtained from infection site was followed by Gram stain and ZN stain & cultured both aerobically and anaerobically. For anaerobiosis during transport of sample; Stuarts transport media was used, and Kanamycin-Vancomycin blood agar was used as plating media. Aanaerobic gas jar- anaerobic gas pack system was used for anaerobiosis. Specimens from chronic wounds were also cultured on LJ media.

The isolates were processed as per standard tests. Antibiotic susceptibility tests were done by Kirby-Bauer technique. ATCC strains were used for quality control of Kirby-Bauer method: *E.coIi*--ATCC 25922, *S.aureus*--ATCC 25923, *P.aeruginosa*--ATCC 27853. For detection of ORSA; Cefoxitin disc diffusion test was performed using 30 µg disc and zone sizes were measured. Gram negative isolates were checked for ESBL production by double disc synergy test using ceftazidime(30mcg), and ceftazidime-clavulunate(30/l0mcg) combination disc.[7] SSI rate was calculated separately for OS and MIS; during the study period taking: number of patients having SSIs as numerator & total number of patients undergoing the above mentioned surgical procedures during the total duration of study period as denominator and multiplying by 100. Ethical clearance was taken from the institutional ethical committee before commencing the study.

III. RESULTS

All the surgical procedures included in our study belonged to clean-contaminated wound category, all the subjects belonged to ASA SCORE III, all the operated patients were given pre-operative antibiotic prophylaxis. The antimicrobials used for surgical prophylaxis were: amoxycillin-clavulunate, ceftriaxone, cefuroxime, gentamicin. We observed 72 cases with SSIs (open surgery: 64 cases and laparoscopic surgery: 8 cases), among 784 post operative patients (open surgery: 396 patients and laparoscopic surgery: 384 patients); during the study period which qualified as an SSI rate of 2.08% in MIS related SSI and 16.16% in OS related SSI. We noted that SSI developing following cholecystectomy performed without laparoscope comprises of 61.29% (38) superficial incisional, 38.7% (24) deep incisional. All the SSIs after MIS noted in this study were deep incisional SSIs. Most of the SSIs (63.89%, 46) following OS were detected at 48 hours following surgery, majority (59.37%, 38) were superficial SSIs, remaining SSIs (28.12%, 18) following OS were detected in the 1st week of surgery and, all MIS related SSIs(8, all deep incisional SSI) were detected during post discharge follow-up at 4th week of surgery.

On primary culture of samples obtained from different infection sites, single isolates were seen in 28 and multiple isolates in 44 instances. Most of the superficial SSIs produced single isolates**. T**he bacteriological profile of chronic SSIs was found to be multispecies comprising of two to three genera. Both OS and MIS present with almost similar bacteriological profile. Most common pathogen isolated from SSIs was *Staphylococcus aureus* (Table 1). *Klebsiella sp* were the second most frequently isolated bacteria. Although aerobic Gram negative bacilli show highest dominance in bacteriological profile of SSIs, but role of the strict anaerobe; Bacteroides fragilis was also detected in the non healing surgical site infections. Superficial SSIs were the commonest SSIs, most commonly caused by *Staphylococcus aureus*. Most common bacteria isolated from Deep incisional SSIs was *Klebsiella sp.* (14 isolates), followed by *Staphylococcus aureus*, *E.coli* and *Pseudomonas sp.* (12 isolates each).

S.aureus (46) was the commonest isolate of which 56.5%;(26) isolates were ORSA; sensitive only to vancomyicn, linezolid, chloramphenicol, gentamicin, amikacin, and, 43.5%;(20) isolates were OSSA (Oxacillin resistant *Staphylococcus aureus*). *Enterococcus sp*.(10) was 100% sensitive to vancomycin and linezolid (Table-2). Amoxycillin-clavulunate, Ceftriaxone, Cefuroxime, Gentamicin are the common antimicrobials used for surgical prophylaxis and also for empirical therapy of SSIs. Gram negative bacilli isolated in our study were highly resistant to these antibiotics (Table-3a & 3b). ESBL producers included *Klebsiella sp.*(50%,10), E.coli(28.57%,4), *Pseudomonas sp*.(42.86%,6). *Pseudomonas sp.*(14) mostly sensitive to cefoperazone-sulbactum combination, meropenem and imipenem and amikacin. All were resistant to cefoperazone & ceftazidime.

IV. TABLES

Table 1: BACTERIOLOGICAL PROFILE AT DIFFERENT SSI SITES

BACTERIAL ISOLATE	NO. OF BACTERIA ISOLATED FROM SSI SITES			T0TAL(% OF n=120)
	SUPERFICIAL	DEEP	ORGAN	
Klebsiella sp	6	**14**	0	20 (16.66)
E.coli	0	12	2	14 (11.66)
Citrobacter spp.	0	2	0	2 (1.66)
Enterobacter spp.	0	2	2	4 (3.33)
Pseudomonas spp.	2	12	0	14 (11.66)
Staphylococcus aureus	**34**	12	0	**46 (38.33)**
Enterococcus spp.	4	6	0	10 (8.33)
β Hemolytic Streptococcus	0	2	0	2 (1.66)
Bacteroidis fragilis	0	6	2	8 (6.66)
TOTAL	46	68	6	**120(n)**

Table 2: % OF GRAM POSITIVE COCCI SENSITIVE TO ANTIBIOTICS

Gram positive cocci	Amoxycillin-Clavulunate	Piperacillin-Tazobactum	Gentamicin	Amikacin	Gatifloxacin	Moxifloxacin	Cotrmoxazole	Doxycycline	Clindamycin	Azithromycin	Vancomycin	Linezolide	Chloramphenicol	Cefoxitin
OSSA(20)	10	100	70	90	50	40	20	50	70	70	100	100	80	100
ORSA(26)	0	0	70	76.9	46.2	30.7	15.3	23	15.3	7.6	100	100	76.9	0
Enterococcus sp.(10)	-	100	-	-	-	-	-	-	-	-	100	100	100	-

Table 3(a): % OF GRAM NEGATIVE BACILLI SENSITIVE TO ANTIBIOTICS

Gram Negative Bacilli	Imipenem	Meropenem	Amoxycillin-Clavulunate	Piperacillin-Tazobactum	Cefuroxime	Ceftriaxone	Cefoperazone	Ceftazidime	Cefepime	Cefoperazone-Sulbactum	Ceftriaxone-Sulbactum
Klebsiella sp. (20)	100	100	0	70	20	30	40	30	40	70	60
E.coli(14)	100	100	14.3	100	0	14.3	42.9	57.1	42.9	100	71.4
Pseudomonas sp.(14)	85.7	85.7	-	100	-	-	28.6	28.6	42.9	100	-

Table 3(b): % OF GRAM NEGATIVE BACILLI SENSITIVE TO ANTIBIOTICS

Gram Negative Bacilli	Amikacin	Gentamicin	Ciprofloxacin	Ofloxacin	Doxycycline	Cotrimoxazole
Klebsiella sp.(20)	100	20	70	60	70	20
E.coli(14)	100	28.6	71.4	14.3	71.4	28.6
Pseudomonas sp.(14)	85.7	71.4	85.7	-	42.9	-

V. DISCUSSION

Our SSI incidence of 16.16% in patients undergoing OS was higher than the finding of Shah FH et al. Incidence rate of SSIs in patients undergoing MIS (2.06%) in our study was also higher than the finding by the same author who reported a rate of 0.92% in MIS related SSIs.[8] Studies by previous workers also confirm that SSI rate is much higher in open surgeries as compared to MIS.[5,8,9,10,11,12] Occurrence of SSIs as such indicates the failure of pre and inter-operative antibiotic prophylaxis and also poor post operative wound care. Incidence of SSI has come down in recent years; which may be due to the fact that more surgeons are switching over to laparoscopic/MIS mode in suitable patients. This enhances the need to determine the incidence of SSIs in laparoscopic and open surgeries separately. Also early discharge and poor follow up may be a reason of lesser detection and less reported cases of SSIs.

Present study findings of 61.29% (38) superficial incisional, 38.7% (24) deep incisional SSI following cholecystectomy performed without laparoscope were close to the findings of Wolcott R.D et al who stated that distribution of infection sites for cholecystectomy performed without laparoscope included: superficial incisional 68.5%; deep incisional 23.9%. But in the present study, all the SSIs following MIS were deep incisional infections, a finding totally incoherent from the findings of Wolcott R.D et al. [13] This may be because of the fact that size of wound is minimal in MIS and good post operative care of skin wound may have prevented occurrence of superficial SSI.

Superficial SSIs are the commonest SSIs in both MIS and OS, most commonly caused by *Staphylococcus aureus* (34).[14] This indicates poor wound care and poor sanitation in post operative period in related patients. Deep SSIs in both are most commonly caused by *Klebsiella sp*.(14); an enterobacteriaceae. These findings match with the findings of Richards C et al, Ali S. A et al and Yadav S et al.[1,15,17] SSIs are mostly caused by MDR hospital flora. Superficial site infections are caused by contamination from skin which is easily colonized by hospital flora. Deep SSIs are caused by contamination from endogenous visceral flora or skin contaminants gaining entry and in fascia and muscles through incision or port sites.[2,3,4] Most probable source of the anaerobe: *Bacterioides fragilis* may be from spillage from GIT handling during operation. Role of anaerobes has been demonstrated by Ali S. A et al, Wolcott R.D et al, Giacometti et al.[13,15,16]

Most sensitive antibiotics in our study were: imipenem, meropenem, cefoperazone-sulbactum, amikacin, piperacillin-tazobactum in *Klebsiella sp.*, *E.coli*, and *Pseudomonas sp.*, and vancomycin, linezolide in ORSA, amikacin, pipetacillin-tazobactum in OSSA. These drug combinations should be used for empirical therapy, though; the prophylaxis must be continued with lower drugs according to the available surgical prophylaxis guidelines to prevent selection pressure and spread of resistance. Predominant role of MDR bacteria in nosocomial infections similar to our study has been proved by many previous workers.[17,18,19,20] Infection by Multidrugresistant bacteria enhances the need of antibiotic stewardship and also indicates the need of proper disinfection of hospital environment.

VI. CONCLUSIONS

Minimally invasive surgery provides the advantage of lesser surgical site infection as compared to open surgery. SSI; like other nosocomial infections; is caused by MDR bacteria and hence microbial culture and antibiotic susceptibility testing is highly recommended for appropriate and prompt treatment and cure of infected cases. Most common individual isolate is *Staphylococcus aureus* following clean contaminated surgical wounds. *Staphylococcus aureus* causes SSI at all incision sites. Bacteria from hospital environment are highly resistant to amoxycillin-clavulunate, ceftriaxone,cefuroxime, gentamicin which are the common antimicrobials used for surgical prophylaxis and also for empirical therapy of SSIs at the study place. Empirical antibiotic therapy which needs to be started at clinicians end before procuring the antibiotic susceptibility test results; may include amikacin and piperacillin-tazobactum or amikacin and cefoperazone-sulbactum and must be switched over to vancomycin or linezolide in case ORSA is the causative agent or other suitable antibiotics in case of ESBL producing etiology; strictly according to the directions of antibiotic susceptibility test report.

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