Journal of Surgical Sciences (2013) Vol. 17 (1) : 18-24

JOURNAL OF SURGICAL SCIENCES

Original Article

MICROBIOLOGY OF INCISIONAL SURGICAL SITE INFECTION

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Abstract

Background: Bacteria responsible for causing Incisional Surgical Site Infection (ISSI) along with their resistance pattern changes over time due to various factors and are a matter of regular scrutiny. Proper understanding of this will help both surgeon and microbiologist to formulate an effective guideline to combat overall SSI.

Objectives: To evaluate responsible microorganisms and their resistance pattern causing ISSI following elective gastrointestinal surgery in our perspective.

Methods: Prospective data were collected on 1122 surgical patients admitted in the surgery department in BSMMU from January 2010 to June 2012 having elective gastrointestinal surgery. Patients operated were followed in the post operative period till discharge and if any ISSI noted, swab from the site of infection was sent for culture and sensitivity reporting using standard bacteriological techniques. Antibiotics were given accordingly.

Results: In this series 1122 wounds were studied of which183(16.31%) cases had ISSI.Wound infection rates, according to clinical wound types were 10.45%, 14.49%, 49% for clean-contaminated,contaminated and dirty wounds respectively. The figures of ISSI according to SSI types were 76.77% for Superficial SSI and 26.23% for Deep SSI.The figures of ISSI according to SSI types were 76.77% for Superficial SSI and 26.23% for Deep SSI. Causative microorganisms were revealed in 74.87% positive cultures. 5.8% wounds had polymicrobial etiology. The common causative organisms were Escherichia coli 55.5%,Staphylococcus aureus 22.6%, Pseudomonas spp. 9.5% and Klebsiella spp. 6.6%.All were 100% sensitive to Meropenem. Next to this Escherichia coli and Klebsiellaspp. were mostly sensitive to Ceftriaxone 62.5% and 100% respectively, Staphylococcus aureus to Doxicycline 75% and Pseudomonas spp. to Ceftazidime 93.7%. Comparison with previously done national and international studies revealed alarming increase in resistance pattern of causative bacterial isolates.

Conclusion: To date no national or in house SSI prevention policy or surveillance guideline exists. Lack of our attention in this issue along with inept, irrational use of antibiotics is definitely adding causative organisms to gain increasing resistance pattern. Before surgical care centers are overwhelmed with SSIs by resistant organisms caution must be taken from all level.

Key Words: Incisional Surgical Site infection, wound infection, resistance pattern

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Received: 30 May 2013 **Accepted:** 15 October 2013

Introduction

Staphylococcus aureus, Escherichia. coli, Pseudomonas spp. and *Klebsiellaspp. sh*are the main culprits found to be causing 'Surgical Site Infection' (SSI) with their variable incidence and resistance pattern in different studies.[1] To add to their atrocity some of these micro bess howwavering multidrug resistance property.[2]Newer Cephalosporin, Quinolone and Carbapenemantibiotics are now a day used for prophylactic and therapeutic purposes to overcome this predicament. But this approach is not cost effective in developing countries.[3]Many a time patients fail to afford the cost of treatment due to poverty. So, treatment course remains incomplete leading to a chance of emerging resistance to that particular drug by those particular bacteria. This is rather a chronic situation; hence high magnitude of resistance is always a possibility.[2]

Controversies exist about choice of antibiotics for prophylaxis and treatment of 'Surgical Site Infection'[3].Although patients present with a variety of sources of infections, every hospital should have antibiotic prophylaxis and therapeutic use protocol. Protocol must be reviewed and updated regularly.[4]Newer agents may become available that are more appropriate and more importantly, resistance pattern may change with time.[2, 3]

The aim of our study was to evaluate responsible microorganisms and their resistance pattern causing ISSI following elective gastrointestinal surgery in our context.

Methods

This observational study comprised of patients admitted and operated for different types of elective gastrointestinal surgery in the surgery department of Bangabandhu Seikh Mujib Medical University during the period from January 2010 to June 2012 where purposive sampling technique was done. Out of 1122 patients having elective gastrointestinal surgery who developed Incisional Surgical Site Infection (183 cases) were included in the study. Patients having operation other than gastrointestinal tract, pediatric patients, patients with operations involving obviously infected wounds and those requiring more than one operation in the same admission were excluded.

Patients demographic and baseline variables were collected from all the patients by thorough history. Detailed clinical examination and baseline investigations and relevant investigations where necessary were done for diagnosis and assessment of general condition of the patients and fitness for general anesthesia.

Skin preparation consisted of shaving prior to surgery. Povidone Iodine solution was used as a pre-operative antiseptic skin preparation. Cloth drapes were standard and steridrapes were not used. After each operation a specific classification was ascertained to the surgical wound, using a standard classification system. In brief, dirty and contaminated wounds were considered to be those with gross contamination or spillage in the operative field, whereas clean—contaminated wounds were those that involved the surgical transaction of a nonsterilemucocutaneous surface. Antibiotic prophylaxis and use was according to the judgment of the attending consultant surgeon. If unexpected problems were discovered at the time of surgery, they were indicated in the wound classification. Operated patients were followed up in the post operative period till discharge. All wounds were examined post-operatively. Those who developed wound complications after discharge and attended out-patient department within 30 days within surgery were evaluated.

During hospital stay according to CDC guideline Superficial Surgical Site Infection (SSSI) was assigned if it involved only the skin or subcutaneous tissue with at least one of the following criteria: purulent discharge with or without culture documentation, organisms isolated from fluid/tissue of the superficial incision, at least one sign of inflammation (e.g. pain or tenderness, indurations, erythema, local warmth of the wound) present, wound is deliberately opened by the surgeon and if the surgeon or clinician declares the wound infected. A wound was not considered a superficial Incisional SSI if a stitch abscess was present. Deep SSI was assigned if it involved deep soft tissues(e.g. fascia and/or muscle) of the incision with at least one of the following criteria: purulent drainage present from the deep incision but without organ/space involvement , fascial dehiscence or fascia deliberately separated by the surgeon because of signs of inflammation, a deep abscess identified by direct examination or during reoperation, by histopathology, or by radiologic examination or if the surgeon or clinician declares that a deep Incisional infection is present.Specimens were obtained for culture from all ISSI and all isolates recovered were identified by standardized methods of culturing. Patient related data was collected using a structured research instrument (data collection format) containing variables of interest.

Results :

Table-I

ISSI rate according to types of wound.

Types of wound	No. of cases	No. of infection
Clean contaminated	201	21(10.45)
Contaminated	621	90(14.49)
Dirty	300	72(24.0)
Superficial ISSI		135(73.77)
Deep ISSI		48(26.23)

(Figures in the parenthesis are percentage)

Table-II

ISSI detection in Postoperative period.

Day	Infection	Discharge	Dehiscence
3rd	6 (9.84%)	3(4.9%)	0
5th	54(88.52%)	48(78.68%)	13(21.3%)
7th	60(98.36%)	55(90.16%)	13(21.3%)

Most of the infections developed within 5th to 7th postoperative day.

Table-III

Culture results of wound swabs. (n=183)

Sex	No. of Wound Swabs	Positive Cultures
Male	115	89 (77.39%)
Female	68	48 (70.59%)
Total	183	137 (74.87%)

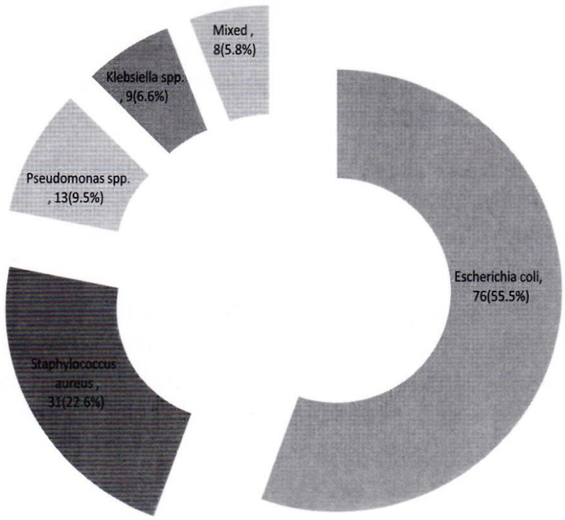

Fig.-2: *Distribution of organisms in positive cultures* (n=137)

Table V

Antibiotic susceptibility pattern (in %) of organisms in positive cultures (n=137)

Antibiotic	*Escherichia coli*			*Staphylococcus aureus*			*Klebsiella spp.*			*Pseudomonas spp.*		
	S	I	R	S	I	R	S	I	R	S	I	R
Penicillin	ND			12.5	12.5	75	ND			ND		
Erythromycin	ND			41	0	59	ND			ND		
Amoxicillin	1	0	99	12.5	0	87.5	12.5	75	100	0	0	100
Doxicycline	14.3	14.3	71.4	75	12.5	12.5	0	33.3	66.7	ND		
Cloxacillin	ND			16.8	20.7	62.5	ND			ND		
Cotrimoxazole	8.5	0	91.5	ND	10	0	90	ND				
Ciprofloxacin	53.4	5.6	41	58.5	0	41.5	95.4	0	4.6	36.3	12.5	51.2
Pefloxacin	ND			ND			ND			57.1	14.3	28.6
Gentamycin	32.2	9.3	58.5	50	0	50	66.7	0	33.3	42.7	6.3	50
Cephradine	ND	35.5	12.5	52	ND	ND						
Cephalexin	28.6	14.3	57.1	ND	33.3	0	66.7	ND				
Ceftazidime	ND			ND			ND			93.7	0	6.3
Ceftriaxone	62.5	15.5	22	57.5	30.3	12.2	100	0	0	57	32.5	10.5
Meropenem	100	0	0	100	0	0	100	0	0	100	0	0
Chloramphenicol	29	10.5	60.5	ND			ND			ND		
Nitrofurantoin	66	4	40	ND			ND			ND		
Nalidexic acid	29.1	10.4	60.5	ND			ND			ND		

ND -Not Done S-Sensitive I-Intermediate R-Resistant

Table VI

Comparison ofAntibiotic resistance pattern of bacterial isolates with different studies.

Study	Amoxicillin	Gentamycin	Cloxacillin	Ciprofloxacin	Ceftriaxone	Meropenem	Nitrofurantoin
Escherichia coli.							
Siguan SS	70%	50%	ND	0%	15%	0%	ND
Miles TD	35.40%	33.30%	ND	10.40%	ND	0%	ND
Mannan	98%	53.50%	ND	21%	22.20%	0%	33.60%
Our series	99.00%	58.50%	ND	41.00%	22.00%	0.00%	40%
Staphylococcus aureus							
Siguan SS	95%	ND	100%	38%	30%	0%	ND
Ikeagwu IJ	63%	ND	89%	ND	ND	0%	ND
Mannan	ND	25%	0%	11.50%	ND	0%	ND
Our series	87.50%	50%	62.50%	41.50%	12.20%	0%	ND
Pseudomonas spp.'s							
Misra RN	ND	88%	ND	53%	ND	ND	ND
Pathmanathan SG	ND	15.50%	ND	16.50%	ND	22.50%	ND
Mannan	ND	50%	ND	31.2%%	12.50%	0%	ND
Our series	100%	50%	ND	51%	10.50%	0%	ND

Discussion

In our series 1122 surgical wounds were studied following elective gastrointestinal surgery where ISSI rate was 16.31% that had similarity with the findings of Watanabe[5] in Japan (15.5%) but Waltz's[6]found lower incidence rate (8.7%)in United States.

Several studies now confirm that the chance of overall SSI progressively rises with the degree of contamination of wound. Cruse PJ et al.[7] in the study of 62,939 patients found that over all infection rates (SSSI+DSSI+Organ/Space SSI) was 7.4% where infection rate in clean contaminated wounds 7.7%, contaminated wounds 15.2%, and dirty wounds 40%. Pattern of SSI at Chittagong Medical College Hospital reported by Ali SL and Khan ANGA[8] found that wound infection rate in clean wounds 25%, clean contaminated wound 28.6% and contaminated wound 54.8%. We only studied Incisional surgical site infection (excluding organ/space SSI) rate that also was rising with degree of contamination namely 10.45% for clean contaminated, 14.49% for contaminated and 24% for dirty operations. Other studies by Weiss et al. [9] in 1999 and Kobayashi [10] in 2008 of SSI also correlate well with our findings. Superficial SSI rate was almost three timesthat of Deep SSI. Davidson[11] and Sergeant G et al.[12] also described similar ratio between Superficial SSI and Deep SSI in their study.

To be in attendance with methodology signs of wound infection with or without discharge and dehiscence were mostly noted between 5th to 7th postoperative days. Wound swab was taken from any wound fulfilling the criteria to be an ISSI and sent to microbiology department for culture and sensitivity report. In this study 25.13 % cultures failed to yield any growth of microorganism even with the presence other signs of ISSI (e.g. purulent discharge or tenderness, localized swelling, redness, heat etc.). It has been reported that presence of anaerobic bacteria, prior use of antibiotics which inhibited the growth of any bacteria in vitro culture might be the cause [13, 14].

It was observed that *Escherichia coli* (55.5%) was the most common organism isolated from ISSI followed by *Staphylococcus aureus* (22.6%), *Pseudomonas spp.* (9.5%) and *Klebsiellaspp.* (6.6%). In an earlier study in Bangladesh Ashraf and Prodhan[15] found that in wound infection *Escherichia coli* (37.5%) was the predominating organism followed by Staph. aureus (21.7%), and *Pseudomonas aeruginosa* (15.1%). In another study, Zamanet al.[16] showed that *Escherichia coli* was the major pathogen in post operative wound infection (60%) followed by *Staphylococcus aureus*

(20%). Ali and Khan[8] (1983) found that *Staphylococcus aureus* was the most common organism for surgical wound infection at Chittagong Medical College Hospital. Another study by Caplan ES and Hoyt NJ[17] showed the organisms identified as causing infection were *Staphylococcus aureus* (25%), *Escherichia coli* (18%), *and Pseudomonas species* (12%) in decreasing order. The dissimilarity with the later two studies may be due to difference in case selection.Caplan ES studied only trauma victim cases whereas Ali and Khan's study included all sorts of surgery not only elective gastrointestinal surgery[8,17].

The resistance pattern was identified using the commonly used antibiotics. *Escherichia coli* was found resistant to Amoxicillin in 99% cases followed by Gentamycin in 58.5%, Ciprofloxacin in 41%, Nitrofurantoin in 40% and Ceftriaxone in 22% cases. Siguan SS[18]in 1990 showed a lower resistance to Ampicillin (70%), Ciprofloxacin (0%) andGentamycin (50%), although a similar resistance was shown against Ceftriaxone (15%). This difference may be accredited to increased use of Ciprofloxacin and Gentamycinwith time. Miles TD et al.[19] showed in their study that *Escherichia coli* had lower resistance to Gentamycin (33.3%), Ciprofloxacin (10.4%) and Ampicillin (35.4%) compared to our study. Emerging resistance against Ceftriaxone is already an alarming issue that needs to be addressed avidly.Meropenem, a highly expensive carbapenem was 100% sensitive against all strains.

In case of *Staphylococcus aureus*, it is most resistant to Amoxicillin (87.5%), followed by Cloxacillin (62.5%), Gentamycin (50%), Ciprofloxacin (41.5%), Ceftriaxone (12.2%) and least resistant to Meropenem (0%). Siguan SS et al.[18]showed similar result to Ampicillin (95%) andCiprofloxacin (38%) but more resistance to Cloxacillin (100%) and Ceftriaxone (30%). In another study Ikeagwu IJ et al.[20]showed a 63% resistance to Amoxicillin which is less than our study and 89% resistance to Cloxacillin which is more. The cause may be due to selection of sample although the trend is similar. Mannan[21] in his study showed 100% sensitivity to Cloxacillin which is completely opposite to our study picture. For Ciprofloxacin (11.5%) and Gentamycin (25%) resistance was quite lower. Although he performed his study in one of the tertiary hospitals of Bangladesh the dissimilarity about sensitivity to Cloxacillin is significant and may be due to smaller study sample and use of different groups of antibiotic.

In this study *Pseudomonas spp.'s* remained resistant to Amoxicillin in all (100%) cases. Although it showed 50% resistance to Gentamycin and 51% to Ciprofloxacin, Ceftriaxone is resistant in 35% cases.Surprisingly *Pseudomonas spp.* was 93.7% sensitive to Ceftazidime and no organism was resistant to Meropenem (0%). In a similar study Misra RN et al.[22] showed 88% resistance to Gentamycin and 53% resistance to Ciprofloxacin which is higher than our study. In another study by Pathmanathan SG et al.[23] showed 15.5% resistance to Gentamycin, 16.5% resistance to Ciprofloxacin and 22.5% resistance to Meropenem, this except for Meropenem is nearly similar to our study. The higher resistance to Meropenem should warn us about its widespread use as we might face a similar picture in future.

Regarding *Klebsiella species* the resistance rate was 100%, 90%, and 66.7% to Amoxicillin,Cotrimoxazole and Cephalexin respectively. Ceftriaxone was sensitive in 100% cases and Ciprofloxacin in 95.4% cases. Resistance pattern of *Klebsiellaspp.* lacks proper understanding due to their rarity. Zamanet al.[16] found few cases of SSI by this microorganism that was only sensitive to Imipenem(100%), another carbapenem similar to Meropenem. The antibiogram of only 09 (6.6%) strains of *Klebsiella spp.* from our patients could not be well compared with others due to low number of isolates.

Far-reaching injudicial exposure of these anti-microbial agents had been the cause behind the magnitude of this sort of resistance.[1, 3, 14-24] In favor of this view Bachoualetal.[24](1998) worked out the mutation of the resistance gene in *Escherichia coli* against fluoroquinolone. Although Gentamycin is cheap and in use for a long period, it still has variable but sometimes remarkable sensitivity pattern. The reason behind this may be due to lack of its oral preparation that to some extent limits its use.The increased resistance to Ciprofloxacin is alarming and in practice its use has already been abandoned in many cases.[25] Ceftriaxone now has become the first line of defense against ISSI.

Inept, reprehensible and random use of antibiotics leading to the development of a wide spectrum of resistant strainsof organisms will forcibly bound us to rely on expensive antibiotics if proper precaution is not accepted and a guideline not formulated and followed at once.[4, 25]We should by no means allow the resistance pattern for newer antimicrobials' like

Meropenem to follow the same fate of Ciprofloxacin and Ceftriaxone.

Conclusion:

ISSI rate being 16.31% in a university hospital following elective gastrointestinal surgery is quite high. Though usual organisms prevailed but they showed increasing resistance pattern to commonly used antibiotics. Ciprofloxacin is on its verge to be abandoned making Ceftriaxone the mostly used first line defense. Meropenem though expensive has excellent sensitivity.

Such high resistance pattern of the microorganisms responsible for ISSI in a specialized surgical care centre like ours is alarming as health care system is thought to be optimum here.To date we surgeons have some but not many sensitive anti-microbial at our disposal to combat the scenario but if trend of antibiotic use is not changed according to proper guideline days are not far away when we would be out of our armors and face life threatening SSI's by resistant organisms. Advent of newer chemotherapeutic agents by no means warrant for their use until unless proven prudently necessary.

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