Wound Etiology, Resistance Pattern and Incidence of Bacteremia in Patients with Surgical Site Infections

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ABSTRACT

Objective — *To determine the wound etiology, antibiotic resistance pattern of pathogens and incidence of bacteremia in patients with surgical site infections (SSI).*

Study design — *Experimental study.*

Place & Duration of study — *Department of Microbiology University of Karachi, from September, 2008 to October, 2012.*

Methodology — *Pus swab (n=250) and blood samples (n=56) were collected from patients having SSIs. Swabs were inoculated on 5% sheep blood agar, MacConkey's agar and Sabrouad dextrose agar and identified by standard microbiological and quick test strip methods. Blood samples were dispensed into blood culture bottles and incubated at 35 °C for 5-7 days. Resistance pattern of isolates were determined by Kirby Bauer disc diffusion technique and results were interpreted as outlined by Clinical Laboratory Standards Institute (CLSI) specifications. E. coli ATCC 25922 and S. aureus ATCC 25923 were used as control strains. Data was analyzed by SPSS 13.*

Results — *In Pus swabs positive growth was obtained in 224 (90%) specimens. Escherichia coli was the commonest pathogen isolated (n=109, 26%) followed by Candida spp. (n=77, 18%), S. aureus (n=73, 17%), Klebsiella spp. (n=66, 16%), Pseudomonas spp. (n=32, 8%), Proteus spp. (n=29, 7%), Morganella spp. (n=17, 4%) and Providencia spp. (n=15, 4%) whereas in blood samples bacteremia was found in 15 (27%) specimens of which E. coli (47%) and S. aureus (33%) were the most common isolates. Gram negative bacteria demonstrated high resistance against commonly prescribed drugs while Polymyxin B showed reasonable activity against these organisms. S. aureus showed high rates of Methicillin resistance with cross-resistance to most antimicrobial agents.*

Conclusion — *Frequency of bacteremia and resistance to antibiotics was high in patients with SSIs.*

Key words — *Surgical Site Infections, Wound Etiology, Antibiotic Resistance, Bacteremia.*

INTRODUCTION:

Surgical site infections are potential severe danger to surgical patients which still stand as the second most frequent form of undesirable hospital events.[1,2] The impact of SSIs on morbidity and mortality has been well documented in many regions of the world.[3] Patients developing SSIs possess a 2-11 times greater risk of death, in contrast to patients with no SSIs.[4] According to Centers for Disease Control and Prevention (CDC), 20% of hospital-acquired infections are postsurgical infections which usually account for an estimated 10 billion dollars for extra health-related expenses annually within United States.

As compared to developed countries surgical site infections are more often reported from resource limited countries due to their infrastructure as well

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as financial restrictions.[2] Postoperative bacteremia is also an important complication of surgery. Many studies documented the fact that 20%-60% of patients along with postoperative bacteremia have wound infections.[5] Surveillance of surgical-site infections is becoming more important given the current situation of increasing antibiotic resistance by pathogens.[6] A war among microorganisms and their susceptibility to drugs is still a problem among community, investigators, physicians and pharmaceutical companies who are trying to find efficient drug treatment.[7] Both medical experts and planning managers inside hospitals have an interest for inspecting SSIs.[8]

The purpose of this particular investigation was not only to determine the etiology of surgical wound pathogens and the incidence of bacteremia among patients undergoing surgery but also to evaluate the resistance pattern of pathogens in order to highlight factors involved in delayed wound healing among patients with surgical site infections.

METHODOLOGY:

Pus swabs (n=250) and blood samples (n=56) were collected from patients who developed any signs and symptoms associated with surgical site infections during a period from September 2008 to October 2012. A pre-designed performa was created and information was compiled prospectively from hospitalized patients by name, sex, age, hospital number, ward and reason of surgery.

Pus swabs were collected from wounds with the help of commercially available sterile cotton swabs and transported to Department of Microbiology, University of Karachi for microbial study. Specimens were inoculated on 5% sheep blood agar (Oxoid, Basingstoke, UK), MacConkey's agar (Oxoid, Basingstoke, UK), and Sabrouad dextrose agar (SDA) (Oxoid, Basingstoke, UK), plates and incubated aerobically at 37°C for 24 hours. Any growth was subsequently identified by standard microbiological and quick test strip methods. Furthermore 6ml of blood collected from patients with a sterile, non reusable syringes were dispensed into blood culture bottles that contain 50 ml of Brain Heart Infusion Broth (Oxoid, Basingstoke, UK), at bed side of the patients and incubated at 35°C for 5-7 days. Culture bottles that showed any sign of growth was subsequently identified by standard microbiological methods. Blind containers which failed to indicate sign connected with growth after 48 hours were re-incubated for 10 days prior to getting dumped as negative.

Isolates screened for possible resistance against a total of 15 agents, were selected from different antimicrobial classes including Aztreonam (ATM, 30µg), Amoxicillin/clvulanic acid (AMC, 30µg), Piperacillin/tazobactam (TZP, 110ug) Gentamicin (CN, 10µg) Polymyxin B (PB, 300 units), Cefuroxime sodium (CXM, 30µg), Minocycline (MH, 30µg), Methicillin (MET, 10µg), Vancomycin (VA, 30µg) Linezolid (LZD, 30µg) Clindamycin (DA, 2µg) (Oxoid, Basingstoke, UK), Ceftazidime (CAZ, 30µg) Ciprofloxacin (CIP, 5µg) Amikacin (AK, 30µg), Doxycycline (DO, 30µg) (BBL, Becton Dickinson and Co., MD, USA) using Kirby Bauer disc diffusion technique. Inocula were prepared in Mueller Hinton broth (Oxoid, Basingstoke, UK), at a density adjusted to a 0.5 McFarland turbidity standard. With a sterile cotton swabs, a final inoculum of about 104 CFU was placed on Mueller Hinton agar plates (Oxoid, Basingstoke, UK). Discs were placed with the help of a sterile forceps. When placed, each disc was lightly pressed to make sure it has the firm exposure to agar surface. Such Petri plates were incubated aerobically at 37°C for 18 hours. Antimicrobial susceptibility was interpreted as outlined by Clinical Laboratory Standards Institute (CLSI) specifications as sensitive and resistant by gauging diameter of inhibition zone. *E. coli* ATCC 25922 and *S. aureus* ATCC 25923 were used as control strains. Data was analyzed by SPSS 13.

RESULTS:

The total number of patients in the study was 250, of which 103 (41%) were females and 147 (59%) males making female to male ratio of 1:1.4. The mean age of patients was 31 year. The infection rate was comparatively high (54%) in the age group of 20-39 year followed by 40-59 year of age groups (20%) as shown in table I. Among 250 pus swabs positive growth was obtained in 224 (90%). *Escherichia coli* was the commonest pathogen Isolated (n=109, 26%) followed by Candida spp. (n=77, 18%), *S. aureus* (n=73, 17%), Klebsiella spp. (n=66, 16%), Pseudomonas spp. (n=32, 8%), Proteus spp. (n=29,7%), Morganella spp. (n=17, 4%) and Providencia spp. (n=15, 4%). In 56 blood samples bacteremia was found in 15 (27%) samples. *E. coli* (47%) was the most common isolate followed by *S. aureus* (33%) and Pseudomonas spp (20%).

The Polymyxin B (91%) and Amikacin (85%) were very active against most of the *E. coli* isolates while these isolates showed high rate of resistance against Azteronam, Ceftazidime and Ciprofloxacin (100%), (97%) and (96%) respectively (table II). *Klebsiella* spp., the fourth most frequent pathogen isolated in our study showed high rates of resistance to

Table I: Age and Gender Distribution of Patients

Age in years	Male (%) n=147	Female (%) n=103	Total (%) n=250
0-19	30 (12%)	17 (7%)	47 (19%)
20-39	84 (34%)	51 (20%)	135 (54%)
40-59	23 (9%)	27 (11%)	50 (20%)
60-79	10 (4%)	8 (3%)	18 (7%)

Table II: Resistance Pattern of Gram Negative Pus Isolates

Antibiotics	E.coli		Klebsiella spp		Pseudomonas spp		Proteus spp	
	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)
Amikacin	15	85	22	78	47	53	70	30
Polymyxin B	09	91	00	100	03	97	77	23
Doxycycline	70	30	57	43	49	51	80	20
Gentamicin	83	17	71	29	74	26	80	20
Ceftazidime	97	03	78	22	76	24	67	33
Amoxicillin/ Clavulanic acid	81	19	79	21	95	05	69	31
Ciprofloxacin	96	04	78	22	93	07	54	46
Cefuroxime	93	07	89	11	94	06	79	21
Aztreonam	100	00	90	10	94	06	87	13
Piperacillin/ Tazobactam	22	78	26	74	62	38	30	70

Table III: Resistance Pattern of Gram Positive Pus Isolates

Antibiotics	Staphylococcus aureus	
	R (%)	S (%)
Vancomycin	0	100
Minocycline	6	94
Linezolid	14	86
Cefuroxime	59	41
Amoxicillin/ Clavulanic acid	52	48
Clindamicin	56	44

Cefuroxime sodium 89%, Amoxicillin/clavulanic acid 79% and Ciprofloxacin 78%. However, Polymyxin B (100% susceptibility) remains very active against this pathogen, the next most active compound was Amikacin, which inhibited 78% of the Klebsiella isolates tested. Pseudomonas spp which accounted 8% of the total isolates, showed extremely high rates of resistance to the majority of the antimicrobial agents tested. The most active compound against this pathogen was the Polymyxin B (97%) whereas resistance was more marked with other antimicrobials. The spectrum rank order of the antimicrobial agents against pseudomonas spp. in terms of percentage of resistance was Amoxicillin/clavulanic acid (95%), Cefuroxime (94%), Azteronam (94%) and Ciprofloxacin (93%). *Proteus spp*. (29 isolates analyzed) showed high rates of resistance to Gentamicin (80%). Aminoglycoside resistance was also elevated among *Proteus* spp. (70%), while they were moderately resistant to fluoroquinolone (Ciprofloxacin 54%). Interestingly, Pipracillin/tazobactam, (70%) showed higher

susceptibility in *in vitro* activity against proteus spp (table II). Gram positive bacterial isolates showed multi drug resistance towards a minimum of 2-6 drugs. In our study, the Methicillin was active against nearly 72 % of *S. aureus* isolates while Ceftazidime was active against only 67% of the *S. aureus*. In addition Minocycline was active compound with 94% susceptibility. Only the Vancomycin showed excellent activity (100%) against these pathogens (table III).

DISCUSSION:

Surgical site infections, representing worldwide threat, are connected with additional complications.[9] Patients who seem to encounter postoperative complications have increased duration of hospital stay, number of readmissions, mortality rates, and expenses.[10] Although the cure and treatment procedures of infectious diseases is in progress, pathogens still poses constant challenge in relation to antimicrobial chemotherapy by means of continuous increase of antibiotic resistant strains. Emergence regarding multi drug resistant strains of pathogens isolated from hospital environment, created a serious concern in patient care.[11]

In the present study we observed that the infection rate was higher in males 147 (59%). This might be due to pattern of injuries sustained and type of surgeries done upon them. An increased number of males have already been documented by other investigators as prone to SSIs.[12]

In this investigation the most prevalent isolated pathogen was *E. coli* (26%). This may be due to the fact that most of the specimens were taken from patients who underwent abdominal surgeries. This can be due incidental spilling of bowel flora during surgery. This finding is similar with studies conducted by other investigators where most often encountered organisms with intra-abdominal infections were *E. coli* and *Enterococcus faecalis.*[13,14] Candida spp (18%) appeared to be the second most frequent isolate in our study this may be the result of profound effect of endogenous contamination from gut of the patients. Lichtenstern et al reported that ICU patients who got gastrointestinal perforations or anastomotic leakage after surgical intervention have high chance of acquiring candida peritonitis.[15] S. aureus was third most common isolate which is similar to findings of other investigators.[16] Same has been found in the survey of Nosocomial Infection National Surveillance Service in which *S. aureus* has been documented as predominant organism of surgical wound.[17]

We observed increased rate of bacteremia (27%) in this setting which is much higher than a study conducted in Spain where they found bacteremia in 18% of cases.[18] Similarly in a study carried out in Carolina, only 11% rate of bacterimia secondary to SSIs was reported.[19]

In the present study the resistance rates were noticeably higher, especially among the Gram-negative isolates. Similar findings were also reported by other investigator.[20] Gram negative bacteria demonstrated a high rate of resistance against Azteronam, Cefuroxime and Amoxicillin/clavulanic acid as reported in literature as well.[21,22] Possibly this could be the consequence of irrational and/or excessive use of antibiotics for considerably longer period of time. Furthermore, the frequent empirical prescription of these antibiotics for a treatment and prophylaxis may also lead to increase rate of resistance.[23] In this study it was revealed that only the Polymyxin B, Pipracillin/tazobactam and Amikacin showed reasonable activity against this group of multi-resistant organisms.

Regarding the resistance associated with *E. coli* highest resistance was observed to Azteronam followed by Ceftazidime and Ciprofloxacin. These findings similar with previous investigations conducted in Pakistan where they found significantly increased resistance in *E. coli* to 3rd generation Cephalosporins as well as Quinolones.[24] The antimicrobial susceptibility results for Gram positive cocci showed very high rates of Methicillin resistance (28%) among staphylococci with cross-resistance to most antimicrobial agents. Only Vancomycin was active against 100% of MRSA. It may be because of its infrequent use and high cost. Minocycline represents a reasonable alternative to the Vancomycin against Methicillin resistant *S. aureus.*

CONCLUSIONS:

Frequency of surgical site infections and bacteremia was high. *E. coli* was the most frequently isolated pathogen. High resistance to frequently prescribed antibiotics was noted.

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