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ORIGINAL REPORT

Bacteriology of Surgical Site Infections and Antibiotic Susceptibility Pattern in Isolates of Postoperative Wound Infections

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Abstract

Background: We aimed to evaluate the isolates of postsurgical infections, and study their sensitivity; so that strategies could be made by using proper antibiotic treatments.

Methods: Study isolates were obtained by swabs/pus from the subjects reported for surgical site infections (SSIs) at surgery department of a governmental tertiary care hospital, Nagpur, India, and were further transferred to the pathology department during the period from June 2009 to November 2011. About 250 cases of surgical site infection were evaluated with isolates form different surgical sites which were surmised to be infected based on clinical evaluation. The isolates were subjected to standard procedures, and antibiotic susceptibility test opting modified Kirby-Bauer disc diffusion technique.

Results: Twelve types of organisms were isolated; most common was Klebsiella species (23.7%), Staphylococcus aureus (20.00%), followed by Escherichia coli (15.1%), Pseudomonas aeruginosa (13.4%), coagulase-negative staphylococci (CoNS) (11.0%), etc. Results suggested 50% of the isolates having Staphylococcus aureus were resistant to methicillin. More than 60% of isolates having Escherichia coli and Pseudomonas aeruginosa were resistant to gentamicin. The number of isolate showing resistance to 3rd generation cephalosporins and the quinolone antibiotics was high.

Conclusions: Surgical site infections crowded with multi-resistant organisms, not only increase the economic burden in the form of antibiotics, but also pose a serious threat to patients undergoing surgery. To avoid such infections, there is an urgent need to follow aseptic and sterilization techniques, also rationale use of antibiotics has to be done.

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Introduction

Surgical site infections (SSIs) account for 14-16 percent among all the hospital-acquired infections in patients undergoing surgery, and are the 3rd most occurring nosocomial infections in patients. Among the patients undergone surgery, SSIs are the commonest nosocomial infections (1). SSI remains a matter of concern for surgical procedures leading to increased rate of morbidity and mortality, and also increases the economic burden (2). The major factor responsible for SSI is the balance between the bacterial burden at the site and the resistance against infection (3,4).

Postsurgical infection remains one of the major concerns among the surgeons presently, as major of these are caused by bacteria having multiple resistant pattern (5). Literature report the involvement of Gram-positive cocci and Gram-negative bacilli in most of SSI cases (5,6).

A close examination of these infections bacteriologically followed by timely feedback to surgeons handling such cases would lead to effective treatment with suitable antibiotics (7). Such an approach would not only guide the surgeons in treating such infections effectively, but also will give them guidelines in deciding proper prophylactic antibiotics to be given before surgeries in order to reduce postsurgical SSI.

The main aim of present study was to evaluate postsurgical infections and the antibiotic sensitivity of the isolates from infection sites of patients undergone various surgeries, which will help in setting recommendations for their prevention and proper treatment of antibiotics.

Materials and Methods

The present study was done at department of

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surgery of a governmental tertiary care hospital, Nagpur, India, from June 2009 to November 2011. The swabs/pus samples in present study were obtained from patients in the General Surgery wards, who had undergone elective surgeries and had developed signs and symptoms of SSI. The surgical sites were considered to be infected in accordance to the set of clinical criteria recommended by the American Center for Disease Control (CDC) Nosocomial Infections Surveillance (NNIS) system (8). The classification of wounds was done on basis of wound contamination class system as proposed by CDC for use in surveillance of SSI, into clean, clean contaminated, contaminated, and dirty wounds.

A total of 2083 cases (1561 men and 522 women) were studied, among which 1214 were cases of clean surgeries, and 869 were cases of clean contaminated surgeries. The specimens of swabs/pus were sourced from surgical sites following standard procedures using a sterile swab. The obtained samples were transferred to the pathology department of hospital for further bacteriological study. Within 2 hours, all the obtained samples were inoculated in MacConkey's agar. The plates were subjected for incubation of 24 hours at 37°C under aerobic conditions, the plates were observed after 24 hours for any growth.

The obtained isolates were identified based on the knowledge of colonial morphology, Gram's staining, available biochemical tests, and by using the Analytical Profile Index (API 20E) galleries for enterobacteriaceae (9). The susceptibility of isolates to antibiotics was studied in accordance to Kirby-Bauer method (10). To test the susceptibility to antibiotics, Mueller-Hinton agar (Difco) was selected. The controls included Escherichia coli ATCC 25922, Staphylococcus aureus ATCC 25932, and Pseudomonas aeruginosa ATCC 27853.

Results

A total of 12 types of major type of organisms (410 positive cultures) were isolated from about 250 cases of SSI. The enteric Gram-negative bacilli were the predominant organisms grown on culture. Klebsiella species were isolated in 97 samples (23.7%), Staphylococcus aureus in 82 samples (20.0%), and Escherichia coli (E. coli) in 62 samples (15.1%) (Table 1).

Further on evaluation of pattern of isolates, it was found that of the 250 culture-positive cases, 136 samples (54.2%) yielded one-microorganism isolates. Klebsiella species were the predominant organisms isolated in 45 cases (33.1%). The other common isolates were Staphylococcus aureus in 27 cases (19.8%) and coagulase-negative staphylococci (CoNS) in 20 cases (14.7%). 2 microorganisms were present in 83 cases (33.3%), 3 microorganisms in 23 cases (9.2%), 4 microorganisms in 3 case (1.2%), and 5 microorganisms in 5 cases (2.1%) (Table 2).

Table 1. Pattern of isolated microorganisms in 250 cases of surgical site infections (SSIs)

Name of organisms	Number (%)
Klebsiella species	97 (23.7)
Staphylococcus aureus	82 (20.0)
Escherichia coli	62 (15.1)
Pseudomonas	55 (13.4)
Coagulase-negative staphylococci (CoNS)	45 (11.0)
Acintobacter	10 (2.4)
Proteus	20 (4.9)
Diptheroids	12 (2.9)
Citrobacter	7 (1.7)
Enterococci	8 (1.9)
Streptococci	6 (1.5)
Candida	6 (1.5)

In the clean operations, in wounds which were infected, the Gram-positive cocci were the main causative agents in this study. Staphylococcus aureus was isolated in 58 cases and CoNS in 35 cases of the clean procedures. The enteric Gram-negative bacilli were the predominant organisms in the clean contaminated operations. Of the 97 Klebsiella species, 70 (72.5%) and of the 62 E. coli isolates, 39 (62.5%) were cultured from clean contaminated procedures (Table 3).

All the bacterial isolates were tested for antibiotic sensitivity using Kirby-Bauer method. The Gram-negative isolates were tested against gentamicin, amikacin, ciprofloxacin, metronidazole, ceftriaxone, cefotaxime and ampicillin. For Pseudomonas strains Piperacillin was included. Klebsiella species were most sensitive to cephalosporins i.e. ceftriaxone (68.6%), cefotaxime (62.8%) and amikacin (62.8%). The sensitivity for the commonly used antibiotics Ciprofloxacin, Metronidazole, Gentamicin and Ampicillin were less than 57.1 % among the Klebsiella and Proteus species. The E. coli, Pseudomonas and Acinetobacter strains were fairly sensitive (> 60%) to almost all the drugs tested. The Citrobacter isolates had a low sensitivity of 28.6% for amikacin, ceftriaxone and metronidazole and 14.3% for gentamicin, cefotaxime and ampicillin (Table 4).

The Gram-positive isolates were tested against ampicillin, penicillin, cefoperazone, metronidazole, gentamycin, amikacin, and ciprofloxacin. The Staphylococcus aureus isolates were highly sensitive to amikacin (74.2%) and cefoperazone (67.8%). Of the 82 Staphylococcus aureus isolates, only 26 (32.2%) were sensitive to penicillin, 48 (58.1%) to metronidazole, 61 (74.2%) to amikacin. Among the coagulase-negative staphylococci, least sensitivity was recorded to ampicillin, metronidazole, and gentamycin (61.1%) (Table 5).

Table 2. The number and pattern of isolated microorganisms in each wound of 250 cases of surgical site infections (SSIs)

1 microorganism [136 (54.2)]	2 microorganisms [83 (33.2)]	3 microorganisms [23 (9.2)]	4 microorganisms [3 (1.2)]	5 microorganisms [5 (2.1)]
Klebsiella species [45 (33.1)]	Staphylococcus aureus and Escherichia coli [13 (15.7)]	Escherichia coli, Klebsiella species, and Pseudomonas species [7 (30.4)]	Escherichia coli, Staphylococcus, Diphtheroids, and Candida [2 (66.7)]	Staphylococcus aureus, CoNS, Escherichia coli, Klebsiella species, and Pseudomonas species [3 (60.0)]
Staphylococcus aureus [27 (19.9)]	Klebsiella species and Pseudomonas species [10 (12.0)]	Staphylococcus aureus, Klebsiella species, and Pseudomonas [6 (26.1)]	Cons, Candida, Staphylococcus, and Pseudomonas [1 (33.3)]	CoNS, Diptheroids, Klebsiella species, Pseudomonas species, and Candida [2 (40.0)]
CoNS [20 (14.7)]	Staphylococcus aureus and Klebsiella species [8 (9.6)]	Staphylococcus aureus, Enterococci, and Proteus species [2 (8.7)]		
Escherichia coli [15 (11.0)]	Staphylococcus aureus and Pseudomonas species [8 (9.6)]	Staphylococcus aureus, Diptheroids, and Candida species [2 (8.7)]		
Proteus species [11 (8.1)]	Staphylococcus aureus and Streptococci [6 (7.2)]	CoNS, Escherichia coli, and Acintobacter species [2 (8.7)]		
Pseudomonas species [8 (5.9)]	Escherichia coli and Klebsiella species [6 (7.2)]	Diptheroids, Pseodomonas species, and Candida species [2 (8.7)]		
Acintobacter species [5 (3.7)]	CoNS and Klebsiella species [5 (6.0)]	Staphylococcus aureus, Escherichia coli, and Proteus species [2 (8.7)]		
Diptheroids [3 (2.2)]	CoNS and Escherichia coli [5 (6.0)]			
Citrobacter species [2 (1.5)]	CoNS and Pseudomonas species [5 (6.0)]			
	Escherichia coli, Pseudomonas species [4 (4.8)]			
	Staphylococcus aureus and Enterococci [3 (3.6)]			
	Citrobacter species and Proteus species [3 (3.6)]			
	Acintobacter species and Enterococci [3 (3.6)]			
	Staphylococcus aureus and Citrobacter species [2 (2.4)]			
	Klebsiella species and Proteus species [2 (2.4)]			

The amounts are presented as number (%).
CoNS: Coagulase-negative staphylococci

Table 3. Organisms isolated in each wound class

Organisms Grown	Total number	Clean wounds	Clean contaminated wounds
		Number (%)	Number (%)
Klebsiella species	97	27 (27.5)	70 (72.5)
Staphylococcus aureus	82	58 (70.7)	24 (29.3)
Escherichia coli	62	23 (37.5)	39 (62.5)
Pseudomonas species	55	6 (10.9)	49 (89.1)
CoNS	45	35 (77.8)	10 (22.2)
Acintobacter species	10	3 (30.0)	7 (70.0)
Proteus species	20	5 (25.0)	15 (75.0)
Diptheroids	12	2 (16.6)	10 (83.4)
Citrobacter species	7	2 (28.5)	5 (71.5)
Enterococci	8	0 (0.0)	8 (100.0)
Streptococci	6	6 (100.0)	0 (0.0)
Candida Acintobacter	6	0 (0.0)	6 (100.0)
Total	410	114 (27.8)	296

CoNS: Coagulase-negative staphylococci

Table 4. Antibiotic sensitivity of Gram-negative isolates

Organisms	Total number	Gentamycin	Amikacin	Ceftriaxone	Cefotaxime	Ciprofloxacin	Metronidazole	Ampicillin	Piperacillin
		Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)
Klebsiella species	97	50 (51.4)	61 (62.8)	55 (57.1)	42 (62.8)	67 (68.6)	61 (42.8)	39 (40.0)	-
Escherichia coli	62	44 (70.8)	52 (83.3)	47 (75.0)	47 (75.0)	52 (83.3)	41 (66.7)	41 (66.7)	-
Pseudomonas species	55	33 (60.0)	38 (70.0)	-	-	38 (70.0)	30 (54.5)	30 (55.0)	36 (65.5)
Proteus species	20	11 (57.1)	14 (71.4)	9 (42.8)	9 (42.8)	14 (71.4)	14 (71.4)	11 (57.1)	-
Citrobacter species	7	1 (14.3)	2 (28.6)	1 (14.3)	1 (14.3)	2 (28.6)	2 (28.6)	1 (14.3)	-
Acinetobacter species	10	10 (100.0)	10 (100.0)	7 (70.0)	7 (70.0)	10 (100.0)	10 (100.0)	7 (70.0)	-

Discussion

SSIs are characterized by occurrence of pus along with inflammation at the site (11). The risk factors leading to postsurgical infection include the type and time required for surgical process, age, history of the patient, the skill of surgeon, the awareness with which the infection control measures were undertaken, and the antibiotic prophylaxis treatment given (12).

A total of 2083 patients were the part of study of either sex having least predisposing factors. The operative factor responsible for causing infections in the selected subjects were associated to the surgical team. In Kotisso and Aseffa study, Staphylococcus aureus and enterobacteriaceae were regarded to be the major microorganism in postsurgical infections (13). But in the present study, the Klebsiella species (23.7%) was the most common isolate followed by Staphylococcus aureus (20.0%), E. coli in (15.1%), Pseudomonas species (13.4%), and coagulase-negative staphylococcus (11.0%). The results were in agreement to study of Anvikar et al. (14).

In our study, the antibiotic suitability pattern of the isolates showed that Klebsiella species were most sensitive to ceftriaxone (68.6%), cefotaxime (62.8%), and amikacin (62.8%).

The percentage of sensitivity showed a decline when tested for the other commonly used drugs like ciprofloxacin (57.1%), gentamycin (51.4%), and metronidazole (42.8%). E. coli was found to be highly sensitive to ceftriaxone and amikacin (83.3%), cefotaxime, and ciprofloxacin (75%). Multidrug resistance in case of citrobacterspecies was found to be much higher, probably because it was a hospital strain. The antibiotic sensitivity pattern was similar to Anvikar et al. study, reported that the organisms responsible for SSIs are resistant to the antibiotics used commonly (14).

The resistance of the Staphylococcus aureus strains to penicillin (68.8%) correlates with the study of Durmaz et al. who demonstrated 60% resistance to penicillin and 28% resistance to methicillin among the Staphylococcus aureus strains (15).

Conclusion

A clear understanding for identifying the SSI as a major hurdle, and to develop a system which can track, analyze, and monitor it, is important. A system comprising committee of hospital infection control should act regularly, and percolate the importance to the grass root of system making suitable recommendations for preventing any resistance incidences. This study will help to overcome issues of hospital morbidity, economic burden, and mortality caused by SSIs.

Conflict of Interests

Authors have no conflict of interests.

Table 5. Antibiotic sensitivity of Gram-positive isolates

Organisms	Total number	Ampicillin	Cefoperazone	Penicillin	Metronidazole	Gentamycin	Amikacin	Ciprofloxacin
		Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)
Staphylococcus aureus	82	48 (58.1)	56 (67.8)	26 (32.2)	48 (58.1)	50 (61.3)	61 (74.2)	45 (54.8)
CoNS	45	28 (61.1)	35 (77.8)	30 (66.7)	28 (61.1)	30 (66.7)	33 (72.2)	33 (72.2)
Diptheroids	12	10 (80.0)	12 (100.0)	10 (80.0)	12 (100.0)	12 (100.0)	12 (100.0)	10 (80.0)
Enterococci	8	4 (50.0)	8 (100.0)	4 (50.0)	8 (100.0)	8 (100.0)	8 (100.0)	8 (100.0)

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