Original article:

Bacteriological profile and antimicrobial resistance of postoperative wound infections: a threat to human health

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Abstract

Background: Postoperative wound infections, the third most common hospital associated infection, reported with a prevalence of 2.5-41.9%, are responsible for prolonged length of hospital stay, increased mortality, morbidity and treatment cost. The prevalence of multidrug resistant organisms is on rise thereby limiting the use of available drugs to treat such severe infections.

Objective: To determine the spectrum of aerobic bacterial pathogens responsible for the postoperative wound infections along with their antibiogram.

Material and Methods: The wound swabs and pus aspirates were collected from suspected infected cases from wards and ICU of G.B.Pant Hospital (GIPMER). The samples were processed in department of Microbiology as per standard techniques. Identification and Antimicrobial susceptibility testing of the isolates was done by VITEK-2 compact automated system and Kirby- Bauer disc diffusion method.

Results: Out of 259 samples received in the laboratory, 216 samples (83%) were culture positive with a yield of 248 bacterial isolates. The gram negative organisms (67%) outnumbered the gram positive organisms (33%) with *Escherichia coli* (31.32%) being the most common followed by *Acinetobacter* species (25.90%) and *Klebsiella* species (24.09%). Among the gram positive organisms, *Staphylococcus aureus* was the most common (71%) with 78% being Methicillin resistant *S.aureus* followed by *Enterococci* species (28%).

Conclusion: The emergence of multidrug resistant organisms has compelled the Researchers to conduct such studies that would guide towards the pattern of ongoing resistance and help in formulation of treatment and preventive strategies so as to curb such emergence.

Keywords: Postoperative wound infections, gram negative bacteria, antibiotic rsistance pattern

Introduction:

Hospital associated infections are one of the major health related problem of concern throughout the world as they pose significant threat to patient care. Postoperative wound infections also known as surgical wound/ site infections are the third most common hospital associated infections accounting for 2-22% of the health care associated infections. [1] Globally, the rates have been reported to range from 2.5% to 41.9%. These infections may be

superficial or deep incisional or may involve organs or body space. Postoperative wound infections are defined by the CDC as the infections that occur within 30 days of a surgical operation for a superficial incision infection and within 90 days for an implant in place. [1]

The causative pathogens of Postoperative wound infections may originate from endogenous or exogenous flora, most commonly from the endogenous flora of the patient's skin, mucous membranes or hollow viscera. These infections are caused due to either one type of microbial species (monomicrobial) or many types of species (polymicrobial). Majority of the studies conducted in India, report the most common pathogens to be *Staphylococcus aureus*, *Enterobactriaceae*, *Pseudomonas aeruginosa*, *Enterococci* and *Coagulase negative Staphylococci*. [2] Earlier, infections with the gram positive organisms were on the higher side. But, recent reports have documented the rise of gram negative organisms as the causative pathogens of postoperative wound infections. [3]

Postoperative wound infections have great impact on the patients health care cost, morbidity, mortality and is associated with delayed recovery and prolonged hospital stay. The management of these infections thus, poses a great challenge to the treating surgeons and this picture is further complicated by the emergence of multidrug resistant organisms. Inadequate hospital infection control practices and inappropriate surgical antimicrobial prophylaxis contribute to the selection pressure favoring the emergence of these multidrug resistant organisms. [2]

The prevalence and antibiogram pattern of pathogens causing postoperative infections varies between regions and hospitals. The knowledge of the causative organisms and their antibiogram is essential for the effective control of postoperative infection and its management. Thus, the present study was conducted with an aim and objective to study the bacterial profile of postoperative wound infections and determine the antibiotic susceptibility pattern.

Material and Methods:

This was a retrospective study that included 259 patients undergoing surgical treatment (Cardiovascular thoracic surgery, Neurosurgery, Gastrointestinal surgery) during the period of 6 months from 15 May-15 November 2017 at G.I.P.M.E.R. New Delhi. Wound swabs and pus aspirates were collected from clinically suspected cases of postoperative wound infections. The surgically operated cases with purulent/serous discharge from the incision and at least one of the signs and symptoms of infection such as pain or tenderness, localized swelling, redness or heat were included in the study. Gram staining of the specimen was done followed by inoculation on Sheep blood agar and MacConkey's agar (HiMedia) and aerobic incubation at 37⁰c for 24 to 48 hrs. Identification and Antimicrobial susceptibility testing was done by VITEK-2 compact automated system and Kirby- Bauer disc diffusion method on Mueller Hinton agar as per CLSI guidelines.

Results:

A total 259 specimen were collected out of which 216 (83%) specimens was culture positive. Out of 216 specimens, 184 (85%) were monomicrobial and 32(15%) were polymicrobial together yielding 248 bacterial isolates. The gram negative organisms 168 (67%) outnumbered the gram positive organisms 80(33%) with *Escherichia coli* (31.32%) being the most common among the gram negative organisms and *Staphylococcus aureus* 57(71%) among the gram

positive organisms. Overall, *Staphylococcus aureus* was the most common bacterial isolate with a prevalence of 52(20.95%) (Table 1)

Majority of the gram negative isolates were resistant to both β-lactam and non β-lactam antibiotics. Among the Enterobacteriaceae, *E.coli* and *Klebsiella* species contributed to maximum resistance followed by *Proteus, Citrobacter and Enterobacter species*. Reduced susceptibility was observed to the Penicillins, Cephalosporins and Fluroquinolones. Least resistance was observed to Aminoglycosides(Amikacin), Carbapenems, Tigecycline and Colistin. Similar pattern of resistance was showed by the nonlactose fermenting gram negative bacteria of *Pseudomonas* and *Acinetobacter* genus. (Table 2)

Antimicrobial profile of most of the gram positive isolates showed resistance mainly to Ampicillin, Amoxycillin-clavulanate and Levofloxacin. Among the 57 *Staphylococcus aureus* strains, 45(78%) were Methicillin resistant (MRSA). No Vancomycin resistance was detected in *Enterococci*. (Bar graph 1)

Discussion:

Although various infection control programs and initiatives have been taken at different levels in the hospitals and community, the evolution and persistence of the infecting pathogens continues. Also, the advent in the diagnostic and management facilities is associated with the introduction of various threatening hospital associated infections, one of which is the postoperative wound infections.

In our study the culture positivity of specimens from postoperative wound infections was 83%. This rate was found to be higher than the rates of studies conducted by Jain K et al [3] (65%) and Saleem et al [4] (71%) and lower than that reported by Negi V et al [5] (96%). G.I.P.M.E.R is a tertiary care centre with surgical departments of Cardiovascular thoracic surgery, Gastrointestinal surgery and Neurosurgery. In our study, maximum cases belonged to the gastrointestinal surgery department where major operations involving the hollow viscera take place. Such anatomical sites when intervened have maximum chances of infection especially with the endogenous flora and this explains the high culture positivity rate in our study.

Out of 216 specimens, 184 (85%) were monomicrobial and 32(15%) were polymicrobial. Our findings correlate with the study by Amatya J et al [6] reporting monomicrobial growth in 77% samples and polymicrobial in 22% of samples. The current study reported the prevalence of gram negative and gram positive bacteria as 168 (67%) and 80(33%) respectively. While considering number of individual bacteria, *Staphylococcus aureus* 57(71%) was the most common. Similar results were reported by other studies [7,8] whereas a study by Jain K et al [3] reported the prevalence of gram negative and gram positive organisms as 47(67.14%) and 23(32.85%) respectively. *Staphylococcus species* are one of the major colonizers of the skin. Operative interventions result in breach of skin, thus facilitating such colonizers to become pathogens. Also, bedsheets, dressings, instruments and hands of health care personnel are found as reservoirs of *S.aureus*.[7]

In the present study, among the gram negative organisms, *E.coli* was the most common followed by *Acinetobacter, Klebsiella, Pseudomonas, Proteus, Citrobacter and Enterobacter species.* Our findings correlated with the other studies [4,9] while a study from Nagpur reported *Pseudomonas aeruginosa* to be the commonest.[10] The high preponderance of the gram negative organisms may be attributed to the performance of maximum abdominal

surgeries in our study thus exposing the patient to the risk of infection with the endogenous flora of gastrointestinal tract. Additionally, these gram negative rods are known to thrive in certain hospital environments such as sinks, respirators, toilets and operation rooms as they survive the harsh effects of disinfectants and antimicrobial drugs.

In the current study, the antibiogram of the bacterial isolates revealed a high incidence of drug resistant organisms. The gram positive isolates showed resistance mainly to Amoxyclav (91%), Ampicillin (90%), Cotrimoxazole (70%), Ofloxacin (65%) and Levofloxacin (63%). Among the 57 *Staphylococcus aureus* strains, 45(78%) were Methicillin resistant (MRSA). Similar high MRSA rates are reported by Jain K et al [3] (48%), Ramesh R et al [11] (66.37%) and Bajaj A et al [12] (76.47%) while Mundhada AS [13] did not report even a single case of MRSA. All the *Staphylococcus aureus* strains were 100% susceptible to Vancomycin, Teicoplanin and Linezolid and better susceptibility was observed towards Gentamicin and Azithromicin. This finding is consistent with the studies by Singh P et al [14], V Negi [5] and Bhattacharya S et al [15] showing 100% susceptibility to Vancomycin and Linezolid. On the contrary, a few studies have mentioned the reporting of 3-18% resistance to Vancomycin. [12] In our study, Enterococcus species showed around 50% susceptibility to Ampicillin and high level Gentamicin. Vancomycin resistance in Enterococcus species was not observed in our study. The antibiogram of gram positive cocci isolates in our study show that Aminoglycosides like Gentamicin can be used as prophylactic drug for postoperative wound infections.

A higher level of resistance was seen in the gram negative organisms isolated in our study. This attribute of multidrug resistance in gram negative organisms is due to the presence of the outer membrane that resists the entry and efficacy of most of the antimicrobials. Most of the gram negative organisms were resistant to β-lactam and non β-lactam antibiotics in a range from 50-100%. *E.coli* and *Klebsiella* isolates showed least resistance towards Amikacin (42,46%), Cefoperazone/Sulbactam (40,50%), Imipenems (46,60%), Tigecycline (13,7%) and Colistin (8,7%) respectively. In addition to increased susceptibility to Carbapenems, Tigecycline and Colistin, *Pseudomonas aeruginosa* showed susceptibility to Aminoglycosides and Piperacillin- Tazobactam too. The Citrobacter species showed resistance to most of the antibiotics tested with 50% susceptibility to Carbapenems, Tobramycin and Tigecyline. Our findings correlate with other studies. [7] A study by Budhani et al [16] also showed similar results stating Imipenem, Gentamicin, Amikacin and Piperacillin/Tazobactum to be most effective antibiotics against the gram negative bacteria. A study by V.Negi et al [5] also reported similar results, but surprisingly the *Acinetobacter* isolates in their study showed increased susceptiblity to most of the antimicrobials. In our study, *Acinetobacter* species showed susceptibility to Colistin and Cefoperazone/Sulbactam as compared to the other classes of antimicrobials.

The distribution of antibiotic resistance to the various antibiotics in our study indicates that majority of the isolates were resistant to the commonly prescribed antibiotics. This varied distribution of the bacterial pathogens in different regions and hospital setups is due to the diversity of study population and is based on pattern of local usage of antimicrobial drugs.

Our tertiary care centre, being a super-speciality hospital, has maximum critical cases referred from other centers that have been mainly managed with broad spectrum antibiotics. Such inappropriate and uncontrolled consumption of antibiotics could be the likely cause of such high antibacterial resistance.

Conclusion:

Postoperative wound Infections with the multidrug resistant organisms have poor outcomes, reduced rate of clinical responses, longer hospital stay and expenses. Thus, the emergence of multidrug resistant organisms has compelled the Researchers to conduct such studies that would guide towards the pattern of ongoing resistance and help in formulation of treatment and preventive strategies so as to curb such emergence. The preponderance of gram negative organisms and their low resistance towards drugs like Aminoglycosides and βlactam/ β lactamase inhibitor combination indicates that these drugs may be used for surgical prophylaxis in our setting. Also, though the rate of resistance against the last resort antibiotics like the Carbapenems, Colistin and Tigecycline is less, judicious use of these antibiotics should be practiced and the pharmaceutical companies should conduct researches for development of novel agents to curtail such notorious organisms.

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Table 1: Distribution of bacterial organisms isolated in culture

Organisms isolated (n= 248)	Frequency of bacterial isolates	Percent
Gram negative organisms (n= 168)		
Escherichia coli	52	30.32
Acinetobacter species	43	25.90
Klebsiella species	40	24.09
Pseudomonas species	26	15.66
Proteus species	3	1.83
Citrobacter species	2	1.20
Enterobacter species	2	1.20
Gram positive organisms (n=80)		
Staphylococcus aureus	57	71
Enterococcus species	23	29

Table 2: Antibiotic resistance pattern of gram negative bacterial isolates

Antimicrobials	E.coli (52)	Klebsiella sp.-(40)	Proteus sp.-(3)	Citrobacter sp.(2)	Enterobacter sp. (2)	Pseudomonas(26)	Acinetobacter (43)
Ampicillin(AMP)	96%	97%	100%	100%	100%	NT	100%
Amoxicillin/Clavulanate (AMC)	82%	95%	100%	100%	100%	NT	100%
Piperacillin/Tazobactam (PT)	73%	85%	100%	100%	100%	38%	98%
Ticarcillin/Clavulanate(TC)	94%	97%	100%	100%	100%	54%	100%
Ceftazidime(CAZ)	96%	95%	100%	100%	100%	88%	100%
Cefuroxime(CXM)	96%	95%	100%	100%	100%	NT	100%
Ceftriaxone(CT)	96%	97%	100%	100%	100%	73%	98%
Cefoperazone/Sulbactam(C/S)	40%	50%	100%	100%	100%	NT	70%
Cefepime (CPM)	100%	100%	100%	100%	100%	92%	98%
Amikacin(AK)	42%	45%	100%	100%	100%	54%	79%
Gentamicin(G)	76%	77%	100%	100%	100%	50%	79%
Tobramicin(TOB)	86%	82%	66%	0%	100%	46%	77%
Netilmicin(NT)	73%	62%	100%	100%	100%	NT	NT
Ciprofloxacin(CF)	100%	97%	100%	100%	100%	NT	100%
Ofloxacin(OF)	98%	95%	100%	100%	100%	NT	100%
Levofloxacin(LE)	96%	90%	100%	100%	100%	69%	100%
Imipenem(IMP)	46%	60%	66%	50%	100%	42%	98%
Meropenem(MR)	50%	65%	100%	50%	100%	18%	98%
Ertapenem(ER)	60%	65%	100%	50%	100%	NT	100%
Colistin(CL)	8%	7.50%	100%	0%	0%	4%	14%
Tigecycline(TG)	13%	7.50%	66%	50%	0%	4%	9%
Ampicillin/Sulbactam(A/S)	NT	NT	NT	NT	NT	NT	86%
Ticarcillin/Sulbactam(T/S)	NT	NT	NT	NT	NT	NT	100%

*NT- Not tested

Bar graph 1: Resistance pattern of Gram positive cocci