ORIGINAL ARTICLE

A Study of Postoperative Wounds Infections with Special Reference to Staphylococcus Aureus - A Study in a Tertiary Care Centre of Vidarbha Region of India

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Abstract

Background: *For the last few decades, nature of wound infection has varied from time to time and place to place. In our region postoperative wound infections are common; however, their prevalence has not been well documented.* ***Material and Methods:*** *A total of 800 patients admitted in two surgical units, two Gynecology and Obstetrics unit, one Orthopaedic unit, one ENT unit, one Ophthalmology unit and one Plastic Surgery unit of Government Medical College & Hospital Nagpur included in the study.* ***Results:*** *116 (14.5%) cases were postoperatively infected. Many factors are behind it like wound contamination, old age, presence of drains and prosthesis, associated medical illness, overcrowding and the presence of multidrug resistant organisms. Most common organism was staphylococcus (26.51%) followed by Psedumonas (18.18%) and Ecoli (15.90%). All Staphylococcus aureus strains (100%) were sensitive to vancomycin followed by 22 strains (62.9%) to erythromycin and methicillin and 20(57.1%) to gentamicin. Only 4 (11.43%) and 3 (8.57%) strains were sensitive to penicillin and ampicillin respectively.* ***Conclusion:*** *Incidence of postoperative wound infection is high in the region. A combined effort should be taken to minimize the problem of postoperative would infection. Present study can provide a baseline data about the post operative wound infection in the region.*

Keywords: *Infections, Postoperative wound, Staphylococcus aureus*

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Introduction

When a patient enters the specialized environment of modern hospital, he is exposed to both known and ill-defined hazards. The infectious hazards have been recognized for many years. Infection is encountered by all surgeons, who by the nature of their craft, invariably impair the first lines of host defense – the mucosal barrier – between environmental microbes and the host's internal milieu. The entrance of the microbes into host tissue is the initial requirement for infection. Surgical infections can be defined as the infection which is from the result of operative treatment and Gilmore[1] defined it as the presence of pus which discharges spontaneously or following opening of wound. Wound infections and other postoperative infections continue to be a problem even though prophylactic antibiotics have reduced the risk. Postoperative wound infection seldom causes death, yet it does prove to an economic burden on the patient and the hospital administration because of prolonged convalescence, prolonged post-operative stay, additional expenditure, nursing care, and an unnecessary waste of time. For effective control of wound infection the data regarding the causative organisms, their antibiotic sensitivity pattern and their special characteristic must be made available. For the last few decades, nature of wound infection has varied from time to time and place to place like Khan et al[2] observed 20.20%, Agarwal et al[3] 49.50% while Anvikar et al[4] observed only 6.09%. In our region, postoperative wound infections are common; however, their prevalence has not been well documented. Hence the present study was undertaken to study the problem of postoperative wound infection in our region.

Materials and Methods

A total of 800 patients admitted in various units of Government Medical College & Hospital Nagpur were included for the study. Various units included were two surgical units, two Gynecology and Obstetrics unit, one Orthopaedic unit, one ENT unit, one Ophthalmology unit and one Plastic Surgery unit. A total of 442 males and 358 females were included in the study. Their age ranged from 5 to 72 years. All the cases were divided into two groups. In one group; planned (routine) operative cases and in another group emergency operative cases were kept. Each patient was followed from the time of admission till the date of discharge from the hospital.

Results

All patients were examined at regular intervals for clinical evidence of infections. Of these 800 cases, 116 cases were postoperatively infected. The overall infection rate in postoperative wounds was 14.5 %. Higher infection rate was observed in older age group ($p< 0.05$). In the age group of 40-49 years, the infection rate was 18.84% while in age group 50-59 years it was 26.51%. 18.91% infection was seen in 60-69 years age group while it was 22.58% in the age group of 70 and above (Table-1).

Table I: Age wise distribution

Age Range	Total Cases	Infected Cases	%
0-9	72	07	9.72
10-19	92	08	8.69
20-29	125	06	4.80
30-39	136	15	9.68
40-49	138	26	18.84
50-59	132	35	26.51
60-69	74	14	18.91
Above 70	31	05	22.58
Total	**800**	**116**	**14.50**

Infection rate was highest among dirty wounds 32.20% (38), while it was 3.85% (12) in clean wound, 9.72% (21) in clean contaminated wound and 29.22% (45) in contaminated wounds. It was also observed that those wounds which had drains (Total 289 cases) developed infection 63 (21.79%) significantly more often than the wounds without drains 53 (10.37%, $x^2 = 18.76$; $p< 0.001$) and patients without preoperative antibiotic prophylaxis 74 (24.83%) develops infection more often as compared to patients under antibiotic coverage 42 (8.37 %). High infection rate was seen in bowel (38.46%), urological (25%) and orthopaedic surgeries (29%) while in clean surgeries like lower segment cesarean section (7.09%) and hernia (5.45%) it was low. In cataract and hydrocele surgeries not a single case of postoperative infection was observed.

A total of 132 strains of microorganisms are isolated from postoperative infected wound. The single infecting organisms were isolated from 100 cases and from the remaining 16 cases more than one organism were isolated (32 isolates). Aerobic bacterias were isolated in 97 cases (82.75%) as single organism while anaerobic bacterias found in only 3 cases (2.59%). Mixed aerobic and anaerobic bacterias were recovered from 8 cases (6.89%). 71 isolates (53.78%) of aerobic gram negative bacilli and 49 isolates of aerobic gram positive cocci (37.12%) were recovered from post-operative wound infection swabs. Staphylococcus aureus was the most frequently isolated organism 35 (26.51%) followed by Pseudomonasaeruginosa 24 (18.18%) and E. Coli 21 (15.90%) table- 2.

Table 2: Microorganism isolated

Organisms	Percentage
Staphylococcus aureus	35 (26.51%)
Coagulase -ve Staphylococci	09 (6.81%)
Pseudomonasaeruginosa	24(18.18%)
Eischerichia coli	21 (15.90%)
Klebsiella pneumonia	15(11.36%)
Proteus mirabilis	06(4.54%)
Proteus vulgaris	03 (2.27%)
Citrobacter speices	03 (2.27%)
Beta haemolytic streptococci	05 (3.78%)
Bacteroides species	07 (5.30%)
Peptostreptococcus species	04 (3.03%)

Out of 21 strains of E. coli, 18 (85.78%) showed sensitivity to cefotaxime followed by 13 strains (61.9%) being sensitive to gentamicin. 80% Kleb. pneumoniae strain were sensitive to cefotaxime while 88% of Proteus were sensitive to Cefotaxime (Table- 3). Out of 35 Staphylococcus aureus strains, all strains (100%) were sensitive to vancomycin followed by 22 strains (62.9%) to erythromycin and methicillin and 20(57.1%) to gentamicin. Only 4 (11.43%) and 3 (8.57%) strains were sensitive to penicillin and ampicillin respectively (Table-4). 31 strains of Staphylococcus aureus showed resistant to penicillin when tested by in-vitro antibiotic sensitivity test by disc diffusion technique. Out of 31 penicillin resistant strains, 28 (90.32%) show Beta lactamase production by rapid acidometric method. 100% Methicillin resistant Staphylococcus aureus strains were resistant to ampicillin and penicillin. 92.30% Methicillin resistant Staphylococcus aureus strains resistant to cloxacillin and 84.61% resistant to gentamicin and erythromycin (Table- 5).

Table- 3: Sensitivity pattern of Gram-negative isolates

Organism	Strains	Gentamicin	Ampicillin	Tetracycline	Cefotaxime
Esch. Coli	21	13(61.9%)	04(19.04%)	3(14.28%)	18(85.78%)
Kleb. Pneumoniae	15	9(60.00%)	03(20.00%)	02(13.33%)	12(80.00%)
Proteus species	9	6(66.67%)	02(22.22%)	01(11.11%)	08(88.89%)
Citrobacter species	3	02(66.66%)	…..	…..	02(66.66%)

Table- 4: Sensitivity pattern of Staphylococcus

Antibiotics	Staphylococci		C –ve Staphylococci	
	Sensitive	Resistant	Sensitive	Resistant
Gentamicin	20(57.1%)	15(42.9%)	06(66.7%)	03(33.3%)
Erythromycin	22(62.9%)	13(37.1%)	05(55.6%)	04(44.4%)
Penicillin	04(11.4%)	31(88.6%)	02(22.2%)	07(77.7%)
Cloxacillin	16(45.7%)	19(54.3%)	04(44.4%)	05(55.6%)
Ampicillin	03(8.57%)	32(91.4%)	02(22.2%)	07(77.7%)
Methicillin	22(62.9%)	13(37.1%)	04(44.4%)	05(55.6%)
Vancomycin	35(100%)	-	08(88.9%)	01(11.1%)

Table- 5: Pattern of drug resistance of MRSA (n=13)

Antibiotic	Sensitive	Resistant
Gentamicin	2(15.4%)	11(84.6%)
Erythromycin	2(15.4%)	11(84.6%)
Penicillin	0(0%)	13(100%)
Cloxacillin	1(7.7%)	12(92.3%)
Ampicillin	0(0%)	13(100%)
Vancomycin	13(100%)	0(0%)

MRSA=Methicillin resistant Staphylococci aureus

Discussion

The problem of post-operative wound infection is seen in both developed as well as developing countries, despite the introduction of meticulous antiseptic regimen in surgical practice. The rate of infection at the incision following surgery depends on the skill of the surgeon and the degree of contamination at the time of operation. Contamination of the postoperative wound with subsequent infections can occur from either an endogenous or an exogenous source. Therefore, no matter how effective an infection control program may be, it is difficult to eliminate all post operative infections because many arise endogenously in patients whose immune defense mechanisms are impaired.

In the present study, post operative infection rate was 14.5% but Yalcin et al[5] observed it as low as 4.5% while Saha et al[6] observed as high as 31.37% and Ahmad et al[7] observed similar to our findings (14%). Low infection rates in developed countries may be due to vast differences in working conditions prevailing in these countries.[5] Anvikar AR et al (1999) in their prospective study of surgical wound found the post-operative wound infection of 6.09%. The study included only clean and clean-contaminated wounds. The high rate of post operative infections in the present study was probably due to the progressive trend towards the operating an older patients and performing more complicated procedures including operations on contaminated and dirty surgical sites. Higher rate of infection in elderly patients observed in the present study is in conformity with the findings of Khan et al.[2] The high infection rate among older patients may be due to longer pre-operative stay, longer duration of operation and carrier state of multi resistant Staphylococci. Reduced immunological efficiency at extremes of age may also play a part.[8]

We found high number of infection cases in contaminated and dirty wounds. The difference in the incidence of infection rate among various types of wounds is self-explanatory. Contaminated and dirty classes of wounds reflect the number of bacteria present at the operative site during the time of operation. Kowli et al[9] also reported the infection rate of 37.6% for clean cases as compared to 83.4% for unclean cases. Similar high degree association was also observed by Miles AA.[10]

In the present study, drain wounds developed infection more often than wounds without a drain. Khan et al[2] Agrawal[3] also found similar trends. Increase in wound sepsis in drain wound is probably due to the nature of operation. Drainage provides an outlet for collected serum and blood and prevents hematoma formation and thus it may diminish the risk of wound infection, but it is also true that the drainage communicates the tissue with the exterior for a longer period and may act as a pathway for pathogenic bacteria, thereby increasing the risk of infection. Leaper DJ et al[11] and Sawyer RG et al[12] also found higher rate of infection in drained wounds.

In the present study, significantly higher infection rate was observed in patients who did not receive preoperative prophylactic antibiotics in comparison to those who received them, ($p < 0.001$). Agrawal et al[3] reported that use of antimicrobial drugs in the pre-operative period destroys the susceptible organisms and then permit the colonisation in nasopharynx, lungs, wounds and gastrointestinal tract with resistant virulent organisms which may be responsible for postoperative wound infection. To be most effective, antibiotics should be administered before operation in a manner that insures a tissue level at the time of incision and they should target pathogens commonly associated with the specific operation undertaken.[13]

We found high infection rates after Bowel surgeries (38.46%), Orthopedic surgeries (29%), Urological surgeries (25%), Cholecystectomy (21.05%) and Appendicectomy (18.18%). The high rate of infection after Bowel surgeries is constant with the known risk associated with abdominal operations and incision of the gastrointestinal tract. The most of these wound infection were treated with drainage and frequent dressings. Bielecki K et al[14] observed similar findings. In Urological surgeries, a large number of operations done were on vesical calculus. The high infection rate in these operations was mainly due to bacterial contamination from infected urine.[2] Most of the Orthopedic operations were performed on potentially contaminated wounds. In the present study, 100 cataract patients were observed postoperatively for the evidence of the infection. No ophthalmic complication occurred after cataract surgeries indicating strict aseptic precautions and prompt correction of associated conditions, mainly correction of lacrimal obstruction due to chronic dacryocystitis. Valenton M et al[15] observed that only 19 patients were infected following cataract surgery during long periods of 19 years.

From 132 isolates *71 (53.78%)* were aerobic Gram negative bacilli, 49 (37.12%) aerobic Gram positive cocci and 11 (8.33%) isolates were anaerobic bacteria. Brook et aI[16] isolated 36% of aerobic bacteria, 16% of anaerobic bacteria, and mixed aerobic and anaerobic growth in 48% of cases. Rodrigo-Tapia JP et al[17] isolated 8% anaerobes from the post-operative wound infection. Among aerobic bacteria, isolation of Gram negative bacilli was more than Gram positive cocci. In recent years Gram negative bacilli have supplanted Gram positive cocci as the cause of majority of local wound infection. Saha SC et al[6] reported the predominant role of Gram negative organism in causation of post operative wound infection. Choojitv W et al[18] isolated 45.12% aerobic Gram negative bacilli and 19.5% aerobic Gram positive bacteria from surgical wound sepsis. Among Gram negative bacilli, Pseudomonas aeruginosa and E. coli were common. Pseudomonas aeruginosa is found to be commonest organism among Gram negative bacilli causing nosocomial infection. There were many studies showing the predominant role of Pseudomonas in causation of hospital acquired wound infection.[3] Oni AA et al[19] studied the pattern of bacterial pathogen in surgical wound infection. Pseudomonas and Klebsiella species emerged as the most important Gram negative organisms. Murthy R et al[20] showed 21% isolation of Pseudomonas species from post-operative wound swabs. Anvikar AR et al[4] and Emele FE et al[21] reported about 21% isolation of Pseudomonas aeruginosa from surgical wound infection. Among Gram positive cocci, Staphylococcus aureus was found common, accounting for 26.51% of wound infection. Roberts S et al[22] reported that 32% of post-operative wound infection were due to Staphylococcus aureus alone. Yalcin AN et al[5] reported 19.7% sepsis rate due to Staphylococcus aureus. Trans TS et al[23] reported the isolation of Staphylococcus aureus in 29.6% cases of post-operative hospital acquired infectioa Anvikar AR et al[4] in their study reported the isolation of 25% isolates of Staphylococcus aureus from surgical wound infection.

In untypable strains, 100% strains showed resistant to penicillin and ampicillin. Bhujawala and Mohopatra[24] showed 27.2% resistant to ampicillin and 66.5% resistant to penicillin in untypable group. Out of 35 strains of Staphylococcus aureus tested for beta-lactamase production in the present study 28 strains (80%) showed evidence of beta-lactamase production, with only 7 strains (20%) being beta lactamase negative. Sengupta et al[25] showed penicillinase production in 91.8% strains. In the present study 31 strains of Staphylococcus aureus were resistant to penicillin when tested in vitro by antibiotic sensitivity test. Out of 31 strains, 28(90.32%) produced the enzyme beta lactamase. The beta lactamase Staphylococcus aureus strains produce enzyme penicillinase which combines with penicillin to form penicillonic acid and thus inactivate the antibacterial effect of antibiotic penicillin. It can therefore be observed that more than 90% of penicillin resistant strains of Staphylococcus aureus produce enzyme penicillinase, suggesting a proposed mechanism of antibiotic resistance of Staphylococcus aureus to antibiotic penicillin.

In the present study, 13 strains of Staphylococcus aureus (37.15%) showed resistance to methicillin by disc diffusion method. Kona K and Arakawa K[26] recovered 35.3% of methicillin resistant staphylococcus aureus (MRSA) from postoperative wound infection. Udaya Shankar[27] reported 20 % prevalence of methicillin resistance Staphylococcus aureus in JIPMER Hospital. In the present study, majority strains of methicillin resistant Staphylococcus aureus were resistant to most of first line antibiotics. Methicillin resistant Staphylococcus aureus showed 100 % resistance to ampicillin and penicillin, 92.30% resistant to cloxacillin and 85.5% to gentamicin and erythromycin. All 13 strains of MRSA were sensitive to vancomycin.

The antibiotic sensitivity of Pseudomonas aeruginosa showed 70.83% strains sensitive to ceftriaxone which was the most effective drug found in our study against Pseudomonal infection. Sensitivity to gentamicin was 54.16% which is in corroboration with the sensitivity range given by Emele FE et al[21]. The resistance of 44.84% strains to gentamicin in our hospital may probably due to the reason that gentamicin is routinely prescribed to our patients as it is easily available and inexpensive.

For the antibiotic sensitivity pattern of Gram negative isolates, the antibiotic used were gentamicin, ampicillin tetracycline and cefotaxime. In the present study 66.66% to 88.89% Gram negative isolates were susceptible to cefotaxime. About 61.9% to 66.66% isolates were sensitive to gentamicin. The high susceptibility of Gram negative isolate to cefotaxime in this study, proved the usefulness of cefotaxime in Gram negative infection.

Among Gram positive isolates, Staphylococcus aureus showed 100% sensitivity to vancomycin followed by 62.86% to erythromycin but least sensitive to ampicillin 8.57%. Coagulase negative Staphylococci showed highest sensitivity to vancomycin (88.89%) and least to ampicillin and penicillin (22.22%). Wisniewska U et al[28] reported antibiotic resistance of Staphylococcus aureus to penicillin (98.8%), ampicillin (98.9%), cloxacillin (38.6%), carbenicillin (32.6%) and doxycycline (45.6%). Kruszynska et al[29] reported the susceptibility pattern of Staphylococcus aureus. 82.6% strains were penicillin resistant, 13.5% strains were methicillin resistant, 20.6% gentamicin resistant. All of the strains were vancomycin sensitive. Anvikar AR et al[4] showed high percentage of resistance of Staphylococcus aureus to various antibiotics including 100% resistance to ampicillin and penicillin, 98% to gentamicin, 95.9% resistance to erythromycin. Suchita Deepak et al[30] showed the sensitivity pattern of coagulates positive Staphylococcus to various antibiotics. More than 60% strains were sensitive to Norfloxacin and ciprofloxacin. 14.70% strains were susceptible to penicillin.

It is seen from the above study that most of the organisms are resistant to commonly used antibiotics. It may be due to overuse of antibiotics resulting in selection of resistant strains. It is necessary to know the sensitivity of various pathogens in the post-operative wound infection as early as possible for two reasons: Firstly, to select the appropriate antibiotics, so as to avoid the emergence or overgrowth of resistant pathogens to currently use antimicrobial and secondly, these resistant pathogens produced in turn, can cause cross infection to other post-operative wounds resulting in the problem of nosocomial infection.

Conclusion

Incidence of postoperative wound infection is high in the region. The infection rate was found to be 14.5%. A plethora of risk factors contributed to high incidence of postoperative wound sepsis. These factors are - wound contamination, old age, presence of drains and prosthesis, associated medical illness, overcrowding and the presence of multidrug resistant organisms. Although Gram negative organisms were isolated frequently from wound sepsis, Staphylococcus aureus was the single larger isolated organism. Marked resistance of isolates to commonly used antibiotics made the need for judicious use of these drugs. 37.14% isolation of Methicillin resistant Staphylococcus aureus strains, non typability of Methicillin resistant Staphylococcus aureus strains and multidrug resistance of Staphylococcus aureus needed further study to investigate the epidemiological pattern of Staphylococcus aureus in the region.

The postoperative wound infection directly and indirectly weakens the economy of patient, his family, hospital administrator and as such a Nation. A combined effort should be taken to minimize the problem of postoperative would infection.

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