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Bacteriological Study of Post-Operative Wound Infections in a Tertiary Care Hospital

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Abstract

Out of 800 patients admitted for surgery 116 (14.5%) suffered from wound infections. Of these, 57 out of 277 (20.58%) were emergency surgery patients and 59 out of 523 (11.28%) were elective surgery. The infection rate was 32.2% in dirty wounds followed by 29.22% in contaminated wounds, 9.0% in clean-contaminated and 3.85% in clean wounds. There were significantly more infections in wounds with drains (21.79%) than without drains (10.37%) P<0.01). Only 8.37% with pre-operative antibiotic prophylaxis developed infection as compared to 24.83% without antibiotic prophylaxis. The bacterial profile showed polymicrobial flora comprising of *Staphylococcus aureus* (26.51%), *Pseudomonas aeruginosa* (18.18%), *Escherichia coli* (15.9%), *Klebsiella pneumoniae* (11.36%), Coagulase negative *Staphylococcus* (6.81%), *Bacteroides* species (5.30%), *Proteus mirabilis* (4.54%), Beta Haemolytic *Streptococci* (3.78%), *Peptococcus* species (3.03%), *Proteus vulgaris* and *Citrobacter* species (2.27%) each. Both Gram positive and Gram negative bacterial isolates were multi drug resistant. Post-operative wound infections are a serious medical problem that has to be tackled due to its increased morbidity, mortality and medical care costs. An active surveillance program is recommended.

Keywords: Wound infections; Post-operative infections; *Staphylococcus*; Gram-negative bacilli

Introduction

When a patient enters the specialized environment of a modern hospital, he is exposed to both known and ill-defined hazards. Infection is encountered when the first line of host defense-the cutaneous or mucosal barrier between environmental microbes and the host's internal milieu is impaired. Infections that result from operative treatment include wound infection, postoperative abscess, postoperative peritonitis, other post-operative body cavity infections, other hospital acquired infections among which are pneumonia, urinary tract infections and vascular catheter related infections [1]. The development of surgical infection depends on several factors like microbial pathogenicity, host defenses, local environmental factors and surgical techniques.

Postoperative wound infection seldom causes death, yet it does prove to be an economic burden on the patient and the hospital administration because of prolonged convalescence, prolonged post-operative hospital stay, additional expenditure, nursing care and an unnecessary waste of time.

For effective control of wound infections and administration of judicious therapy, the data regarding the causative organisms, their antibiotic sensitivity patterns and their special characteristic must be made available. With this point of view, the present study was undertaken to study the problem of post-operative wound infection in our hospital in reference to various factors directly or indirectly related to wound infection.

Material and Methods

A total of 800 patients admitted in two surgical units, two Gynecology and Obstetrics unit, one orthopedic unit, one Ear, Nose and Throat (ENT) unit, one ophthalmology unit and one plastic surgery unit of Government Medical College and Hospital, Nagpur were included in the study. Of the 800 patients, 442 were male and 358 were female. Patients were specified into two groups:

1. Planned elective operative cases

2. Emergency operative cases

The operative wound was inspected at frequent intervals for clinical evidence of infection. When infection was suspected, three swabs were taken by using sterile cotton swab sticks. One swab was placed in a sterile bulb containing Stuart's transport medium for isolation of anaerobic organisms. The second swab was used for Gram staining and the third inoculated on plates of Nutrient agar, Blood agar and McConkey's agar respectively. Swabs in Stuart's medium were inoculated on blood agar plate containing Gentamicin and incubated in MacIntosh Fildes jar using palladized asbestos catalyst, for 48 hours by evacuation and replacement with 90% hydrogen and 10% carbon dioxide. Effective anaerobiosis was ensured using Methylene blue as an indicator. All the isolates of *Staphylococcus* species were subjected to DNAase test [2] and Oxford strain of *Staphylococcus aureus* was used as the control strain. The other isolates including *Pseudomonas* *aeruginosa*, *Escherichia coli*, *Klebsiella,* Proteus, Beta Haemolytic *Streptococcus* and *Citrobacter* were identified using standard identification protocols [3]. The anaerobic organisms grown were identified in stained smear into 2 broad groups: a) *Bacteroides* species b) *Peptostreptococcus* species.

Staphylococcus aureus NCTC 6571, *Pseudomonas aeruginosa* NCTC 10662 and *Escherichia coli* NCTC 10418 were used as the standard control strains for antibiotic sensitivity testing. The antibiotic sensitivity testing was done using Kirby Bauer disc diffusion technique [4]. The antibiotic discs used were according to the local prescribing pattern as per the antibiotic policy of the Hospital. For Gram positive cocci discs of Penicillin (10 units), Erythromycin (15 μgm), Cloxacillin (5 μgm), Gentamycin (10 μgm), Ampicillin (10 μgm) and Vancomycin (35 μgm) were used. For *Pseudomonas* isolates discs of Amikacin (30 μgm), Ceftriaxone (30 μgm), Cefotaxime (30 μgm), Gentamycin (10 μgm), Ciprofloxacin (5 μgm) and Norfloxacin (10 μgm). For other Gram negative isolates discs of Cefotaxime (30 μgm), Ciprofloxacin (5 μgm), Norfloxacin (10 μgm), Gentamycin (10 μgm), Ampicillin (10 μgm) and Tetracycline (30 μgm) were used.

Centre for Disease control (CDC) criteria were used for defining the type of surgical wound [5].

Clean: non traumatic wound, no inflammation, no break in technique. Respiratory, alimentary and genitourinary tract not entered.

Clean contaminated: non traumatic wound, minor break in technique. Respiratory, alimentary or genitourinary tract entered without significant spillage.

Contaminated: Fresh traumatic wound or operative traumatic wound in which there is a major break in technique, gross spillage from gastrointestinal tract, genitourinary or biliary tract.

Dirty: traumatic wound from dirty source, faecal contamination, foreign body or retained devitalized tissue. Operative wound in which acute bacterial inflammation or perforated viscous encountered.

The statistical analysis was done by standard methods. The infection rate in different types of wounds was calculated as χ^2 test by using the statistical package for social sciences (SPSS), version 22. A p-value <0.05 was considered statistically significant.

Results

Of the total 800 patients 116 (14.5%) suffered from wound infections. The infection rate in routine and emergency surgery was calculated and it was observed that the infection rate was high in emergency surgery i.e.57 cases out of 277 got infected (20.58%) while in routine elective surgery the infection rate was found to be 11.28% (59 cases out of 523) (χ^2=12.63; p<0.001).

Out of 800 cases, 312 (39.00%) were classified as having clean wounds. Of these, 12 developed wound infection with an infection rate of 3.85%. Out of the 216 (27.00%) clean-contaminated wounds, 21 (9.72%) became infected post-operatively while there occurred high infection in potentially-contaminated wounds i.e., 45 out of 154 (29.22%). The infection rate was highest among dirty wounds, which were 38 out of 118 wounds (32.20%). The infection rate in different types of wounds is shown in Table 1. The 63 (21.79%) out of 289 wounds with drains developed infection significantly more often than 53 (10.37%) out of 511 wounds without drains. (χ^2=18.76; p<0.001). The effect of the pre-operative antibiotic therapy and infection rate showed 74 out of 298 (24.83%) patients without pre-operative antibiotic prophylaxis developed infection that was more as compared to 42 (8.37%) out of 502 patients under antibiotic coverage.

Type of wound	No.	No. of Infections (%)
Clean	312	12 (3.85)
Clean contaminated	216	21 (9.72)
Contaminated	154	45 (29.22)
Dirty	118	38 (32.2)
Total	**800**	**116 (14.5)**

Table 1: Infection rates related to wound types.

Table 2 shows the infection rates in various surgeries including bowel surgeries 38.46% and orthopedic surgeries 29%. The post-operative infection rate was high among patients with certain medical illnesses such as malignancy, diabetes mellitus and others that are depicted in Table 3. A large number of different bacteria were isolated. The type of bacteria and their frequency of isolation are shown in Table 4. Anaerobic bacteria were isolated in 11 specimens of which 7 were *Bacteroides* species and 4 were *Peptostreptococcus* species.

Surgery	Total no. of cases	No. of cases infected	Percentage
Lower segment caesarean section	155	11	7.09
Hysterectomy	45	6	13.33
ENT surgeries	100	11	11
Plastic Surgeries (Including skin grafting)	100	14	14
Orthopedic surgeries (including open reduction, prosthesis, amputation)	100	29	29
Bowel surgeries	52	20	38.46
Urological surgeries	32	8	25
Appendicectomy	22	4	18.18
Cholecystectomy	19	4	21.05
Hernia surgeries	22	1	4.54
Hydrocele surgeries	18	-	-
Cataract surgeries	100	-	-
Others	35	8	22.85
Total	**800**	**116**	**14.50**

Table 2: Infection rates in various surgeries.

Out of 35 *S. aureus* isolates 13 (37.14%) were resistant to Erythromycin, 15 (42.86%) to Gentamycin, 31 (88.57%) to Ampicillin and 32 (91.42%) to Penicillin. The common Gram negative bacillary isolates viz. *E. coli*, *Klebsiella* and *Proteus* species were also multi drug resistant. Of these 45 Gram negative isolates 7 (15.6%) were resistant to Cefotaxime, 12 (26.7%) to Ciprofloxacin, 16 (35.6%) to Norfloxacin, 17

(37.8%) to Gentamycin, 36 (80.0%) to Ampicillin and as many as 39 (86.7%) to Tetracycline. The resistance profile of 24 isolates of *Pseudomonas aeruginosa* showed resistance to Amikacin by 5 (20.8%) strains while 7 (29.2%) were resistant to Ceftriaxone, 10 (41.7%) to Cefotaxime, 11 (45.8%) each to Ciprofloxacin and Gentamycin and 16 (66.7%) to Norfloxacin.

Predisposing factors	Total no. of cases	No. of cases infected	Percentage
Anemia	54	22	40.74
Malignancy	47	29	61.70
Diabetes	23	14	60.86
Chronic illness	19	10	52.63
Immunodeficiency state	5	3	60.00
Others	21	13	61.90
(Others include Hypertension, dehydration, UTI and obesity)			

Table 3: Correlation of predisposing factors with infection rate.

Organism	No. isolated (%)
Staphylococcus aureus	35 (26.51)
Coagulase neg. *Staphylococcus*	9 (6.81)
Pseudomonas aeruginosa	24 (18.18)
Escherichia coli	21 (15.9)
Klebsiella pneumoniae	15 (11.36)
Proteus mirabilis	6 (4.54)
Proteus vulgaris	3 (2.27)
Citrobacter species	3 (2.27)
Beta haemolytic *Streptococci*	5 (3.78)
Bacteroides species	7 (5.30)
Peptostreptococcus species	4 (3.03)
TOTAL	**132**

Table 4: Incidence of various microorganisms.

Discussion

Despite the introduction of meticulous antiseptic regimen in surgical practice, post-operative wound infections do occur in the patients and a number of exogenous and endogenous factors play an important role in the occurrence of these infections. In the present study, out of 800 patients 116 got infected post operatively giving the post-operative infection rate of 14.5%. Several workers have quoted the percentage of post-operative wound infections in range of 10% to 76.9% [6-10]. The present rate of post-operative wound infections in the study could be attributed to the progressive trend towards operating the older patients and performing more complicated procedures including operations on contaminated and dirty surgical sites.

The infection rate in different wound types was statistically significant (Table 1). The difference in infection rates in clean and contaminated wounds is self-explanatory. Contaminated and dirty wounds reflect the number of bacteria present at the operation site at the time of surgery. Similarly presence of drain led to development of wound infections with increased frequency. Ideally drainage provides an outlet for collected serum and blood and prevents haematoma formation, diminishing the chances of infection; nevertheless presence of drain for a longer time may act as a pathway for pathogenic bacteria to enter the wound, thereby increasing the risk of infection.

Similarly, there was statistically high infection rate in emergency surgeries as compared to the elective ones. Similar observations have been made by others [7,9,11]. In emergency surgeries, a combination of various factors like physical condition of the patient, operations on the potentially contaminated sites i.e., intestinal perforations, obstructions, strangulated hernia, short time interval for preparing the case for operation and lacking of rigorous aseptic measures due to urgency may predispose the individual to the infection.

The preoperative prophylactic antibiotic significantly prevents the post-operative wound infections. However, the use of antibiotics in the preoperative period may destroy susceptible organisms and permit colonization with resistant virulent organisms [7]. To be more effective a manner that ensures substantial tissue level at the time of incision and should target the pathogens commonly associated with the specific operation undertaken [12].

The overall infection rate in different kinds of surgeries was higher when compared to that of Yalcin et al. [13] and Anvilkar et al. [9]. This is due to the low general resistance of the patients of lower socio-economic strata, complicated cases referred from rural areas, more number of emergency surgeries performed on contaminated wounds and unhealthy living conditions as another contributory factor.

Amongst different kinds of surgery, higher infection rates were noted after bowel surgeries (38.46%), orthopaedic surgeries (29%), urological surgeries (25%), cholecystectomy (21.05%) & appendectomy (18.18%), which was expected and the reasons are well known [14].

The associated medical illness in patients undergoing surgery was seen in 40-62% patients developing post-operative wound infections. This is due to impaired host defenses in these patients and longer hospitalization for correction of underlying disease leads to increased risk of colonization by hospital strains of bacteria.

The bacterial isolates obtained in the study indicate a polymicrobial flora. Similar observations are also made by others [7,9,13]. The prevalence of pathogens varies from place to place and hospital to hospital. A large number of infections are caused by Gram-negative bacilli; however the single most common bacterial isolate was *Staphylococcus aureus*. The different bacterial isolates commonly found were *Pseudomonas aeruginosa*, *E. coli* and *Klebsiella* species, all known to be hospital pathogens. In the present study, isolation of anaerobic bacteria was very infrequent.

The antibiotic sensitivity profile of isolates revealed that a large number of multidrug resistant strains were prevalent in the hospital environment. Thus, it may be mentioned that post-operative wound infections occur with more frequency than ideally they should occur. A plethora of predisposing and risk factors are responsible for these infections. A large number of different types of bacteria are responsible for these infections. Hence, more stringent steps are needed to reduce the incidence. More importantly, whenever the infection occurs, proper laboratory identification of the pathogen along with its sensitivity profile must be obtained to treat the patient with proper antibiotics as well as to keep a watch whether it is causing cross-infection or resulting in spread as a hospital infection.

The incidence of incisional surgical site infection in patients undergoing elective colorectal resection was substantially higher than generally reported in the literature [15]. In a study that was undertaken to determine the infection rate of wound following emergency caesarean section showed that the use of fusidic acid reduced the infection rate by six times. The relation of fusidic acid to wound infection was statistically significant (p=0.0460) [16]. It was reported that robotic and laparoscopic hysterectomies were associated with a significantly lower risk of surgical site infection and shorter hospital stays [17]. Of the 7630 laparoscopic and robotic hysterectomies identified, 399 patients (5.2%) had complications including urinary tract infection (2.1%) and superficial surgical site infection (1.0%). Operative time ≥ 240 minutes was associated with increased overall complications [18]. A study showed that the overall complication rates of robotic and open sacrocolpopexy for post-hysterectomy were not significantly different, including the rates of ureteral or bowel injury and urinary tract infection [19]. Post-operatory infections in orthopedic surgeries pose a significant risk and the use of antibiotics increases the population of pathogens exhibiting resistance against them. Silver nanoparticles appear to be a new therapeutic avenue for their safety and their antimicrobial activity. They can be embedded in bone cement for the prevention of infections [20].

Martov and collaborators reported that in patients with a negative baseline urine culture undergoing ureteroscopy for renal or ureteral stones, rates of postoperative urinary tract infections were not reduced by preoperative antibiotic prophylaxis. High American Society of Anesthesiologists score and the female gender were specific risk factors for postoperative infection [21]. A study showed that in 556 patients undergoing urological laparoscopic procedures 14 surgical site infections (2.5%) were identified at mean postoperative day 21.5. The authors concluded that these infections are infrequent complication following laparoscopic surgery and mostly associated with prolonged operative time and increasing body mass index [22].

Conclusion

Post-operative wound infections are a serious medical problem that has to be tackled due to its increased morbidity, mortality and medical care costs. An active surveillance program is recommended.

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