BACTERIOLOGY AND ANTIBIOTIC SUSCEPTIBILITY OF WOUND INFECTIONS IN A TEACHING HOSPITAL, BENGALURU
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ABSTRACT: Breach in the skin with exposure of subcutaneous tissue due to trauma, surgeries, burns, diabetic ulcers, etc. is known as a Wound. Successful invasion and proliferation by either one or more species of microorganisms will result in the infection of wound which may result in formation of pus. Infection can be due to either endogenous or exogenous bacteria. AIMS: To find the pattern of the bacterial isolates and their susceptibility patterns from the wound samples. METHODS AND MATERIALS: A total of 420 patients with wound infection were included in the study. All the bacterial isolates were isolated and identified according to the standard microbiological techniques. Antimicrobial susceptibility testing was done by Kirby Bauer disc diffusion method. RESULTS: 327 bacterial isolates were isolated and identified from 442 specimens from 420 patients. Gram negative bacteria were predominant followed by gram positive bacteria. Staphylococcus aureus was predominant in gram positive organisms. Escherichia coli were predominant in gram negative organisms. Meropenem was the most sensitive antibiotic for gram negative bacteria and linezolid was the most sensitive antibiotic for gram positive bacteria. CONCLUSION: The successful management of wound infection depends on the knowledge of the most prevalent organisms and their antibiotic susceptibility profile along with infection control practices. KEYWORDS: Antimicrobial susceptibility, Escherichia coli, Gram positive organisms, Gram negative organisms, Staphylococcus aureus, Wound infection.

INTRODUCTION: Breach in the skin with exposure of subcutaneous tissue due to trauma, surgeries, burns, diabetic ulcers, etc is known as a Wound. Microbial colonization and proliferation will be seen due to the moist, warm and nutritive environment in the wounds.(1) Successful invasion and proliferation by either one or more species of microorganisms will result in the infection of wound which may result in formation of pus. Infection can be due to either endogenous or exogenous bacteria.(2) The endogenous organisms usually originate from the respiratory, urogenital and gastro-intestinal tracts. The commonest gram positive organisms are Staphylococcus aureus and Staphylococcus epidermidis and the commonest gram negative organisms are Pseudomonas aeruginosa, Escherichia coli, Klebsiella species and Proteus species.(3)

Wound infections are one of the most common hospital associated infections which results in prolonged hospital stay, increased trauma care, increased treatment cost and morbidity.(4,5) Despite the advances in infection control practices, the control of wound infections is still an uphill task due to development of drug resistance.(6,7) Treatment with an effective and appropriate antimicrobial agent for the wound infection to prevent the drug resistance requires knowledge of the most common microorganisms responsible for the infection and its susceptibility pattern.(8) Hence this present study was conducted to find the pattern of the bacterial isolates and their susceptibility...
patterns from the wound samples for the improvement in treatment and reduction of the drug resistance.

MATERIALS AND METHODS: A prospective study was done in Rajarajeswari Medical College, Bengaluru over a period of one year from January to December 2015. A total of 422 patients with wound infections were included into the study from both in-patients and out-patients of the surgery department. Institutional ethical committee was approved.

The samples were inoculated onto 5% Sheep Blood agar and MacConkey agar which was incubated at 37°C for 24 hours. All the bacterial isolates were identified by biochemical tests as per standard microbiological techniques. Antimicrobial sensitivity testing was performed on Mueller Hinton Agar plates by disk diffusion method and interpreted as sensitive, intermediate or resistant according to Clinical and laboratory standards institute (CLSI) 2014 guidelines.

The data was processed with Microsoft Excel 2007 and were expressed as percentile. The chi-square test was used for assessment of association of variables and p < 0.05 was considered as statistically significant for all statistical analysis.

RESULTS: A total of 440 pus specimens from 422 patients were cultured. The age ranged from 12 to 85 years with a mean age of 46 years. The male: female ratio was 1.85: 1. The age and gender wise distribution of the wound infection is shown in Table 1.

Table 2 shows the percentage of isolation of bacteria from wound specimens. In our study, there was no growth seen in 148 specimens. Bacterial growth was seen in 292(66.3%). Single bacterial growth was seen in 252(86.3%) specimens. Polymicrobial isolates were seen in 40(13.6%) cases. The organisms isolated in wound infections are shown in Table 3. The most common organism isolated was Escherichia coli 74(22.6%) followed by Staphylococcus aureus 68(20.7%) and Klebsiella pneumonia 36(11%).

The antimicrobial susceptibility pattern of gram positive bacterial isolates is given in the table 4 and gram negative bacterial isolates in table 5. MRSA was seen in 16(23.5%) isolates out of 68 isolates. Multi drug resistant gram negative bacteria was seen in 45(20%) out of 224 isolates.

DISCUSSION: Wound infection is a challenging and a major concern to prevent or reduce the mortality and morbidity. The primary goal is to prevent the infection but once the infection has occurred then the wound management practices by either antibiotic treatment or wound dressing along with antibiotics would be the best practices. For this, antibiotic susceptibility testing should be done to treat with the appropriate antibiotic.

In this study, male patients (65%) were predominant when compared to female patients (35%). This correlates to Kranthi K et al.(5) where 66% were males and 34% were females. On the contrary, studies by Gautam et al,(11) Mohammed et al,(12) and Bessa LJ et al,(13) showed female preponderance. Majority of the specimens were received from the patients in the age group of 51-60 years followed by 41-50 years probably because of the co-morbid conditions like diabetes or other immunosuppressive conditions whereas Gautam et al,(11) study of 200 samples shows higher incidence in the age group of 21-30 years. Gram negative organisms (67.8%) were the predominant as compared to gram positive organisms (32.2%) in the wound specimens in our study. This finding correlates with kranthi K et al,(5) Roel T et al,(14) and Mohammed et al,(12) but study of Gautam et al,(11) showed gram positive organisms as the predominant bacterial isolates recovered.
Staphylococcus aureus was the predominant organism in gram positive bacteria and Escherichia coli was the predominant in gram negative bacteria which correlates with the other studies\(^{5,12,13,14}\). Pseudomonas species was predominant among gram negative bacteria in Gautam et al\(^{1(11)}\) and Mehta M et al\(^{1(15)}\) studies.

Linezolid was the most sensitive antibiotic for the gram positive organisms followed by doxycycline, chloramphenicol, vancomycin and gentamicin. Gram positive organisms were least sensitive to penicillin G followed by ciprofloxacin and trimethoprim/sulfamethoxazole. Meropenem was the most sensitive antibiotic for gram negative organisms followed by imipenem, tobramycin and amikacin. Gram negative organisms were least sensitive to ampicillin followed by cephalexin and cefuroxime.

The organism's pattern and sensitivity of the organisms to different antibiotics varies from place to place according to the antibiotic prescription pattern in the surrounding areas, immunity of the patient, age and wound cleaning practices. The limitation of this study was that only aerobic organisms were studied, anaerobic or fungal etiology of the wound infection has not been studied.

**CONCLUSION:** The successful management of wound infection depends on the knowledge of the most prevalent organisms and their antibiotic susceptibility profile along with infection control practices. Early treatment with the appropriate antibiotic may reduce the rate of antibacterial resistance and also reduce the morbidity and hospital stay of the patient. Gentamicin and ofloxacin are the antibiotics of moderate sensitivity against both gram positive and gram negative organisms in our study.

| Age Group (years) | Male | Female | Total |
|-------------------|------|--------|-------|
| 11 - 20           | 17   | 12     | 29    |
| 21 - 30           | 49   | 22     | 71    |
| 31 - 40           | 40   | 20     | 60    |
| 41 - 50           | 54   | 33     | 87    |
| 51 - 60           | 60   | 32     | 92    |
| 61 - 70           | 40   | 21     | 61    |
| 71 - 80           | 14   | 7      | 21    |
| 81 - 90           | 0    | 1      | 1     |
| **Total**         | 274(65%) | 148(35%) | 422(100%) |

**Table 1: Age and Gender wise Distribution of wound infection**

| Sl. No. | Authors                     | No. of Wound Samples | Percentage of Bacterial Isolates |
|---------|-----------------------------|----------------------|---------------------------------|
| 1.      | Gautam et al\(^{1(11)}\)   | 200                  | 75%                             |
| 2.      | Mohammed et al\(^{1(12)}\) | 150                  | 81.3%                           |
| 3.      | Bessa LJ et al\(^{1(13)}\)| 312                  | 69.5%                           |
| 4.      | Kranthi K et al\(^{1(5)}\)| 500                  | 85%                             |
| 5.      | Roel T et al\(^{1(14)}\)   | 614                  | 75.9%                           |
| 6.      | Present study               | 440                  | 66.3%                           |

**Table 2: Percentage of bacterial isolates from various studies**
### Table 3: Distribution of bacterial isolates in wound infection

| Organisms                                      | Total Isolates | Percentage |
|------------------------------------------------|----------------|------------|
| Escherichia coli                              | 74             | 22.6       |
| Staphylococcus aureus                         | 68             | 20.7       |
| Klebsiella pneumoniae                         | 36             | 11         |
| Pseudomonas aeruginosa                        | 29             | 8.8        |
| Proteus mirabilis                             | 23             | 7          |
| Non-fermenting gram negative bacilli          | 19             | 5.8        |
| Other pseudomonas species                     | 16             | 4.9        |
| Klebsiella oxytoca                            | 11             | 3.4        |
| Enterococcus species                          | 10             | 3.1        |
| Coagulase Negative Staphylococcus             | 9              | 2.8        |
| Proteus vulgaris                              | 8              | 2.5        |
| Streptococcus species                         | 8              | 2.5        |
| Diphtheroids                                  | 8              | 2.5        |
| Morganella morganii                           | 3              | 0.9        |
| Citrobacter species                           | 3              | 0.9        |
| Enterobacter species                          | 2              | 0.6        |
| **Total**                                     | **327**        | **100**    |

### Table 4: Antimicrobial sensitivity pattern of gram positive wound isolates

| Sl. No. | Antibiotics                        | No. of Isolates Tested | Sensitivity % |
|---------|------------------------------------|------------------------|---------------|
| 1.      | Penicillin G                       | 97                     | 11.3          |
| 2.      | Ampicillin                         | 105                    | 60            |
| 3.      | Amoxicillin/Clavulanic acid        | 105                    | 75            |
| 4.      | Gentamicin-High                    | 10                     | 90            |
| 5.      | Gentamicin                         | 97                     | 85.7          |
| 6.      | Ciprofloxacin                      | 97                     | 32.2          |
| 7.      | Ofloxacin                          | 97                     | 66.7          |
| 8.      | Trimethoprim/Sulfamethoxazole      | 87                     | 53.1          |
| 9.      | Clindamycin                        | 105                    | 90            |
| 10.     | Erythromycin                       | 105                    | 72.1          |
| 11.     | Linezolid                          | 105                    | 100           |
| 12.     | Vancomycin                         | 105                    | 100           |
| 13.     | Teicoplanin                        | 105                    | 100           |
| 14.     | Chloramphenicol                    | 87                     | 93.8          |
| 15.     | Doxycycline                        | 87                     | 94.2          |
Table 5: Antimicrobial sensitivity pattern of gram negative wound isolates

| Sl. No. | Antibiotics                        | No. of Isolates Tested | Sensitivity % |
|--------|-----------------------------------|------------------------|---------------|
| 1.     | Ampicillin                        | 155                    | 13.5          |
| 2.     | Piperacillin                      | 124                    | 62.5          |
| 3.     | Amoxicillin/Clavulanic acid       | 168                    | 29.6          |
| 4.     | Piperacillin/Tazobactam           | 153                    | 75.2          |
| 5.     | Cefuroxime                        | 168                    | 19.7          |
| 6.     | Ceftazidime                       | 159                    | 74            |
| 7.     | Ceftriaxone                       | 168                    | 50            |
| 8.     | Cefotaxime                        | 167                    | 40.7          |
| 9.     | Cefepime                          | 168                    | 56.8          |
| 10.    | Cephalexin                        | 169                    | 15.9          |
| 11.    | Aztreonam                         | 189                    | 56.8          |
| 12.    | Ertapenem                         | 222                    | 59.7          |
| 13.    | Imipenem                          | 222                    | 95.9          |
| 14.    | Meropenem                         | 222                    | 98.3          |
| 15.    | Amikacin                          | 193                    | 79.3          |
| 16.    | Gentamicin                        | 196                    | 64.8          |
| 17.    | Tobramycin                        | 64                     | 80            |
| 18.    | Ciprofloxacin                     | 195                    | 39.2          |
| 19.    | Ofloxacin                         | 195                    | 65            |
| 20.    | Trimethoprim/Sulfamethoxazole     | 143                    | 42            |

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