Aerobic Bacterial Profile of Post-Operative Wound Infections and their Antibiotic Susceptibility Pattern

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A B S T R A C T

According to Ministry of Agriculture, Government of India the estimated production of fruits in year 2017 is 92 million tones which are more than 2% than the last year but only 2.2% of produced fruits and vegetables were processed in food processing sector in India. In our country people prefer to consume fruits directly. Rest of the produce material destroys due to various factors. To increase the use of agro produce in processing and to reduce the waste, the present study was conducted in which fruit squashes were prepared incorporating fruit juices of lemon, pineapple, orange, amla, raw mango + ginger + mint and extracts of rose and khus. The prepared squashes were subjected to two groups and their organoleptic attributes were assessed. Nine (9) point Hedonic rating scale was used for organoleptic analysis of fresh squashes. Results revealed that various organoleptic attributes, i.e. app., colour, taste, flavour, consistency and overall acceptability of all seven squashes get ≥ 7 hedonic scores by both groups indicating that the squashes were liked moderately to very much by them. The taste, flavour and acceptability of these squash are very good. These squashes were acceptable among both the study groups. Hence, it can be concluded that these products can be served as ready to drink products and any one can drink it and refresh himself/herself.

Keywords
Squash, Organoleptic attributes, Fresh, Fruits.

Introduction

Post-operative wound infections or Surgical Site Infections (SSI) are defined as infections occurring within 30 days after operation for superficial incisional SSI and for operations without implant in place; within 1 year if implant is in place (as per CDC guidelines 1999). However the recent guideline states that infections occurring within 90 days (if implant is in place) are considered as SSI for deep incisional SSI and organ space SSI (CDC 2015 guidelines). Post-operative wound infections are one of the health care associated infections which account for 22% of HCAI, and are second most common HCAI (Gupta, 2012). In India, the SSI incidence varies from 4.04% to 30% (Bangal et al., 2014). Three major factors contribute to post-operative wound infection: a) degree of microbial contamination of the wound during surgery, b) duration of operative procedure, c) host factors (age, obesity, malnutrition, diabetes, carrier state i.e., chronic Staphylococcal carriage, immunosuppression, anaemia, renal failure, radiation etc) (Beilman et al., 2015, Barie, 2012).
Microbiology of SSI depends on the nature of surgery, incision location and body cavity/hollow viscous entry during the procedure. Skin flora is responsible for most of the SSI as they are inoculated into the incision during operation (Barie, 2012).

Most common appearance of SSI is between the 5th and 10th day after operation (Verma et al., 2012). Post-operative wound infections can be caused through exogenous or endogenous bacteria (Shanthi et al., 2012).

As per the data obtained from the National Nosocomial Infections Surveillance System of the CDC 2007, *Staphylococcus aureus* and *Streptococcus pyogenes* are the most common causative agents in clean surgery.

The common organisms associated with abdominal and gynaecological surgeries are *Escherichia coli*, *Klebsiella* species, *Pseudomonas* species, *Acinetobacter* species, *Staphylococcus aureus* and *Streptococcus* species.

Urological surgeries commonly have infections with *Pseudomonas* species and *Acinetobacter* species. *Staphylococcus aureus* and gram negative bacilli are commonly found in infections of Orthopaedic surgeries (Gupta, 2012).

Post-operative wound infections are associated with considerable morbidity and mortality, substantial health care costs, delayed recovery and prolonged stay in hospital by a median of 2 weeks.

There is risk of acquiring SSI even after discharge and the incidence is 2%. Also, these patients are more likely to be readmitted to the hospital (Kitembo et al., 2013).

Increase in multidrug resistant microorganisms is causing a serious therapeutic problem for surgeons. Hence it is necessary to know the prevalent organisms and their antibiogram for early initiation of the treatment (Bibi et al., 2012). Though it is not possible to eliminate post-operative wound infections, they can be reduced to a minimal level which could benefit the patient as well as the medical resources used (Shanthi et al., 2012).

This study was undertaken to study the aerobic bacterial profile of post-operative wound infections and to determine their antibiotic susceptibility pattern.

To isolate the aerobic bacterial pathogens from clinically suspected post-operative wound infections and also to determine their antibiogram.

**Materials and Methods**

This study was conducted in the department of Microbiology in a tertiary care hospital in Mangaluru, from October 2013 to March 2015. The material for the study was obtained from the samples (of patients with signs and symptoms of post-operative wound infections) that were sent to the department of Microbiology from various surgical units.

**Inclusion criteria**

1. Age > 18years; 2. Surgical procedures performed within any of the following designated surgical services: General surgery, Orthopaedics, Obstetrics and Gynaecology (OBG) 3. Exudate samples from Surgical Site Infection

**Exclusion criteria**

1. Age < 18 years; 2. Surgical procedures performed in departments other than general surgery/orthopaedics/OBG; 3. Infected burn wounds; 4. Stitch abscess; 5. Episiotomy wound infection.
Methods of processing

Direct microscopic examination of the gram stained smear. Sample inoculation onto plates of MacConkey agar and 5% sheep blood agar by rolling over the agar and streaking from primary inoculum using a sterile bacteriological loop. The plates were then incubated aerobically at 37°C for 24 hours and if there was no growth, it was further incubated for 48 hours. Any growth on the media was further identified to the species level using relevant biochemical tests.

Antibiotic susceptibility testing was done on Mueller Hinton Agar using Kirby Bauer’s disc diffusion method, according to CLSI guidelines.

Phenotypic identification and detection of Methicillin Resistant Staphylococcus aureus (MRSA) and Extended Spectrum Beta Lactamase (ESBL) producers as per CLSI guidelines.

All the Staphylococcus aureus isolates were screened for mecA-Mediated Oxacillin resistance using the surrogate marker cefoxitin (30 µg).

Quality control

*S. aureus* ATCC 25923 – mecA negative
*S. aureus* ATCC 43300 – mecA positive

Screening test for detection of inducible clindamycin resistance

All the Staphylococcal isolates were screened for detection of inducible Clindamycin resistance by disk diffusion method by placing Erythromycin (15 µg) and Clindamycin (2 µg) which were placed 15–26 mm apart. Presence of a D-zone (flattening of the inhibition zone adjacent to Erythromycin disk) indicated that the isolate had inducible resistance to Clindamycin.

Detection of Extended Spectrum Beta Lactamase (ESBL) production

This method was performed for *Escherichia coli* and *Klebsiella* pneumoniae isolates in our study.

Screening test

Initial screen test was done by disk diffusion method on Mueller Hinton Agar (MHA). The test colony suspension of turbidity of 0.5 Mc Farland was lawn cultured onto MHA and Ceftazidime 30 µg and Cefotaxime 30 µg disks were placed. It was then incubated 37°C, ambient air, for 16-18 hours. Ceftazidime zone of ≤22 mm and Cefotaxime zone of ≤27 mm were considered to be positive for ESBL screening. Quality control strain: *Klebsiella pneumoniae* ATCC 700603

Phenotypic confirmatory test

Confirmatory test for ESBL production was carried out by Disk Diffusion method. The test colony suspension of turbidity of 0.5 Mc Farland was lawn cultured onto MHA and following antimicrobial disks were placed: Ceftazidime 30µg; Ceftazidime-clavulanate 30/10µg; Cefotaxime 30µg; Cefotaxime-clavulanate 30/10 µg. It was then incubated at 37°C, ambient air, for 16-18 hours. A ≥ 5 mm increase in a zone diameter for either antimicrobial agent tested in combination with clavulanate v/s the zone diameter of the agent when tested alone was confirmed for ESBL production.

Results and Discussion

Incidence of post-operative wound infection (Table 1)

A total of 4,829 surgeries were performed during the study period in the department of Orthopaedics (2,290), Obstetrics and Gynaecology (873) and Surgery (1,666).
Eighty two of these patients suffered from post-operative wound infection. The overall infection rate is being 1.7%.

Our finding is similar to a study by Shah et al., (2015) from Mumbai, who reported an overall incidence of 1.6%. Bangal et al., (2014), Golia et al., (2014), Korol et al., (2013), have reported SSI incidence of <5%. In contrary, studies by Mundhada et al., (2015) and Mawalla et al., (2011) have reported a higher incidence of SSI.

The incidence of post-operative wound infection was 4.01% in obstetrics and gynaecological surgeries in this study. Incidence of 2.8%, 6.12% and 7.47% has been reported by Bangal et al., (2014) from Loni, Bhadauria et al., (2013) from Wardha and Rahman et al., (2011) from Dhaka respectively. Devjani et al., (2013) from New Delhi reported a higher incidence of SSI (24.2%).

The incidence of SSI was 1.74% among patients undergoing orthopaedic surgeries in this study. Jain et al., (2013) have reported 22.58% of SSI in their study in Bhopal. In the present study, rate of post-operative wound infection was least (0.42%) in operations conducted in department of general surgery. Incidence of 5%, 11.7% and 39% has been reported by Sahu et al., (2009), Maheshwari et al., (2013) from Meerut and Apanga et al., (2014) from Ghana.

There may be inappropriate recording of incidence of post-operative wound infection because all patients who developed post-operative wound infection may not have approached our hospital.

**Gender distribution (Table 2)**

There were a total of 35 males and 47 females in our study, the ratio of male to female being 1:1.34. Male to female ratio was 4:1 in orthopaedic patients and 1:1.33 in patients admitted under general surgery.

**Age distribution (Figure 1)**

Amongst the patients with post-operative wound infection, the incidence was higher in the age group of >48 years (35.37%) followed by 38-47 years (30.44%), 28-37 years (24.39%) and 18-27 years (12.9%). In this study age >48 years was found to be a risk factor for developing SSI. Ahmed M et al., (2007), Bandaru et al., (2012), Saxena et al., (2013) have also stated that age >50 years is a risk factor for developing SSI. We also noticed that number of post-operative wound infection increased as the age increased. Mahesh CB et al., (2010) have observed a similar finding in their study. Higher incidence of post-operative wound infection in the elderly age group may be attributed to malabsorption, malnutrition, low healing rate, low immunity, underlying chronic disorders.

**Risk factors (Table 3)**

We found Diabetes Mellitus and advancing age as risk factors among patients who developed post-operative wound infection. Razavi et al., (2005), Ahmed et al., (2007) and Apanga et al., (2014) have also noted a similar finding in their study. Hyperglycaemia has deleterious effects on host immune function especially on function of neutrophils. Poor control of glucose during surgery and in the peri operative period increases the risk of infection and worsens outcome from sepsis.

We also observed multiparty as the risk factor in 28 of 35 (80%) obstetrics and gynaecology patients. Bhadauria et al., (2013) and Rahman et al., (2011) have also stated a similar finding. This may be attributed to malnutrition and anaemia due to repeated child birth.
Type of surgeries conducted (Table 4)

Fracture repair was associated with highest number of post-operative wound infections (38 out of 82) followed by abdominal hysterectomy (29.27%), emergency Caesarean section (10.98%). Modified radical mastectomy and inguinal hernia repair constituted 2.44% each. Rest of the operative procedures constituted for 1.22% of post-operative wound infections (Total hip replacement, Total knee replacement, Elective LSCS, Postpartum sterilization, Laparoscopic appendicectomy, Open appendicectomy, Laparoscopic adhesiolysis and appendicectomy).

Post-operative wound infections among elective and emergency surgeries (Table 5)

In the present study elective surgeries were associated with higher number of post-operative wound infections (56.1%) when compared to emergency surgeries (43.9%). In our study risk factors were more in patients who underwent Obstetrics and Gynaecological surgeries. This may have contributed to increased incidence of post-operative wound infections in elective surgeries than in emergency surgeries.

However the rate of infection was found to be more in emergency surgeries than elective surgeries among patients who underwent surgery in the department of Orthopaedics and General surgery. Patel et al., (2012) reported higher infection rate in patients who underwent emergency surgeries than elective surgeries because emergency surgeries are more often involved with complications and more number of dirty cases. Shahane et al., (2012) reported a higher SSI rate in elective surgeries (7.9%) when compared to emergency surgeries (2.7%).

Time of presentation of SSI (Table 6)

More than half of the patients presented with post-operative wound infection in the post-operative period of 3-10 days (53.66%) followed by 11-30 days (21.95%), 31-60 days (12.12%), >3 months-6 months (4.88%), >6 months-1 year (3.66%), 61-90 days (2.44%). Only one patient presented on post-operative day 2 with SSI. When considering the new guidelines of surgical site infections by CDC (2015), 7 cases that presented after 90 days will have to be excluded.

Since CDC 1999 guidelines were available during the study period, the data of patients who presented with SSI after 90 days has been included and analysed.

Majority of the Obstetrics and gynaecological patients (28 out of 35) had SSI in the post-operative period of 3-10 days, the data was further divided and analysed. It was observed that 9 among them (32.14%) presented with SSI on post-operative day (POD) 8 followed by 17.86% on POD 9; 14.29% on POD 5, 7 and 10; 7.14% on POD 6. Rahman et al., (2011) also noticed that majority of their patients (52%) presented with SSI during the post-operative period of 6-10 days. Bhadauria et al., (2013) reported that majority of the patients presented with SSI after 4 days of operation. Our finding indicates that the source of infection was mainly from the patients, wards, surroundings, attendants etc.
**Table 1. Incidence**

|          | Total number of surgeries performed | Total number of cases infected |
|----------|------------------------------------|-------------------------------|
| ORTHO    | 2290                               | 40 (1.74%)                    |
| OBG      | 873                                | 35 (4.01%)                    |
| SURGERY  | 1666                               | 07 (0.42%)                    |
| **Total**| **4829**                           | **82 (1.70%)**                |

**Table 2. Gender distribution**

|          | MALE | FEMALE | TOTAL |
|----------|------|--------|-------|
| ORTHO    | 32   | 08     | 40    |
| OBG      | -    | 35     | 35    |
| SURGERY  | 03   | 04     | 07    |
| **TOTAL**| **35**| **47**| **82**|

**Table 3. Risk factors**

| Risk factors / Department | ORTHO (n=40) | OBG (n=35) | SURGERY (n=07) | TOTAL (n=82) | Percentage |
|---------------------------|--------------|------------|----------------|--------------|------------|
| Diabetes Mellitus         | 09           | 05         | 01             | 15           | 18.29%     |
| Hypertension              | 03           | 01         | 01             | 05           | 6.10%      |
| Advanced age              | 16           | 09         | 04             | 29           | 35.37%     |

**Table 4. Type of surgeries conducted**

| Department                      | Type of surgery                        | Number (%)     |
|---------------------------------|----------------------------------------|----------------|
| Orthopaedics (n=40)             | Fracture repair                        | **38 (73.08%)**|
|                                 | Total hip replacement                  | 01 (1.22%)     |
|                                 | Total knee replacement                 | 01 (1.22%)     |
| Obstetrics and Gynaecology (n=35)| Elective LSCS                          | 01 (1.22%)     |
|                                 | Emergency LSCS                         | 09 (10.98%)    |
|                                 | Abdominal hysterectomy                 | 24 (29.27%)    |
|                                 | Post-partum sterilization              | 01 (1.22%)     |
| Surgery (n=07)                  | Laparoscopic appendicectomy            | 01 (1.22%)     |
|                                 | Open appendectomy                      | 01 (1.22%)     |
|                                 | Modified radical mastectomy            | 02 (2.44%)     |
|                                 | Inguinal hernia repair                 | 02 (2.44%)     |
|                                 | Laparoscopic adhesiolysis and appendicectomy | 01 (1.22%) |
| **TOTAL**                       |                                        | **82**         |

**Table 5. Post-operative wound infections in emergency and elective surgeries**

|          | Emergency | Elective | Total |
|----------|-----------|----------|-------|
| ORTHO    | 23        | 17       | 40    |
| OBG      | 09        | 26       | 35    |
| SURGERY  | 04        | 03       | 07    |
| **TOTAL**| **36 (43.90%)** | **46 (56.10%)** | **82 (100%)** |
### Table 6 Time of presentation

| Time of presentation | ORTHO According to 1999 CDC guidelines | OBG According to 2015 CDC guidelines | SURGERY | TOTAL (n, %) According to 1999 CDC guidelines | According to 2015 CDC guidelines |
|----------------------|----------------------------------------|--------------------------------------|---------|---------------------------------------------|-----------------------------------|
| <3 days              | 01                                     | 01                                   | -       | -                                           | 01 (1.22%)                       |
| 3-10 days            | 12                                     | 12                                   | 28      | 04                                          | 44 (53.66%)                      |
| 11-30 days           | 08                                     | 08                                   | 07      | 03                                          | 18 (21.95%)                      |
| 31-60 days           | 10                                     | 10                                   | -       | -                                           | 10 (12.12%)                      |
| 61-90 days           | 02                                     | 02                                   | -       | -                                           | 02 (2.44%)                       |
| >3 months-6 months   | 04                                     | -                                    | -       | -                                           | 04 (4.88%)                       |
| >6 months-1-year     | 03                                     | -                                    | -       | -                                           | 03 (3.66%)                       |
| TOTAL                | 40                                     | 33                                   | 35      | 07                                          | 82 (100%)                        |

### Table 7 Presenting symptoms

| Symptoms            | ORTHO (n=40) | OBG (n=35) | SURGERY (n=7) | TOTAL (n=82) |
|---------------------|--------------|------------|---------------|--------------|
| Number              | %            | Number     | %            | Number       | %            | n, %       |
| Fever               | 10           | 25%        | 7            | 20%          | 02           | 28.57%     | 19 (23.17%) |
| Purulent Discharge  | 35           | 87.5%      | 24           | 68.57%       | 03           | 42.86%     | 62 (75.61%) |
| Wound gaping        | 05           | 12.5%      | 08           | 22.86%       | 01           | 14.29%     | 14 (17.07%) |
| Pain and tenderness | 21           | 52.5%      | 09           | 25.71%       | 04           | 57.14%     | 34 (41.46%) |

### Table 8 Aerobic bacterial profile of post-operative wound infection

| Organisms isolated       | ORTHO | OBG | SURGERY | TOTAL (n, %) |
|--------------------------|-------|-----|---------|--------------|
| *Staphylococcus aureus*  | 17    | 17  | 02      | 36 (73.47%)  |
| *Escherichia coli*       | -     | 03  | 03      | 06 (12.24%)  |
| *Klebsiella pneumoniae*  | 03    | -   | -       | 03 (6.12%)   |
| *Pseudomonas aeruginosa* | 01    | 01  | -       | 02 (4.08%)   |
| *Proteus mirabilis*      | -     | 01  | -       | 01 (2.04%)   |
| *Klebsiella pneumoniae + Escherichia coli* | 01 | - | - | 01 (2.04%) |
| TOTAL                    | 22    | 22  | 05      | 49 (100%)    |
Table 9 Antibiotic susceptibility pattern of Staphylococcus aureus

| Antibiotics | ORTHO n=17 | OBG n=17 | SURGERY n=02 | TOTAL n=36 |
|-------------|------------|----------|--------------|------------|
| P           | 5.88%      | 5.88%    | 0            | 5.55%      |
| GEN         | 76.47%     | 70.59%   | 50%          | 72.22%     |
| E           | 52.94%     | 58.82%   | 0            | 52.78%     |
| CD          | 76.47%     | 76.47%   | 0            | 72.22%     |
| TE          | 64.71%     | 88.24%   | 100%         | 77.78%     |
| CIP         | 29.41%     | 41.18%   | 0            | 33.33%     |
| COT         | 76.47%     | 70.59%   | 50%          | 72.22%     |
| C           | 88.24%     | 94.12%   | 100%         | 91.67%     |
| LZ          | 100%       | 100%     | 100%         | 100%       |
| VA          | 100%       | 100%     | 100%         | 100%       |

P-Penicillin, GEN-Gentamicin, E-Erythromycin, CD-Clindamycin, TE-Tetracycline, CIP-Ciprofloxacin, COT-Cotrimoxazole, C-Chloramphenicol, LZ-Linezolid, VA-Vancomycin

Table 10 Antibiotic susceptibility pattern of Enterobacteriaceae

| Antibiotics                        | Escherichia coli n=07 | K. pneumoniae n=04 | P. mirabilis n=01 |
|------------------------------------|-----------------------|--------------------|-------------------|
| Amikacin                           | 71.42%                | 50%                | 100%              |
| Gentamicin                         | 28.57%                | 25%                | 100%              |
| Ceftazidime                        | 14.29%                | 25%                | 100%              |
| Ceftriaxone                        | 14.29%                | 25%                | 100%              |
| Cefotaxime                         | 14.29%                | 25%                | 100%              |
| Cefipime                           | 14.29%                | 25%                | 100%              |
| Imipenem                           | 100%                  | 100%               | -                 |
| Meropenem                          | 100%                  | 100%               | 100%              |
| Piperacillin-tazobactam            | 100%                  | 100%               | 100%              |
| Ciprofloxacin                      | 14.29%                | 25%                | 100%              |
| Levofloxacin                       | 28.57%                | 25%                | 100%              |
| Cotrimoxazole                      | 14.29%                | 100%               | 100%              |
| Chloramphenicol                    | 57.14%                | 100%               | 100%              |
Table.11 ESBL producers

| Organisms            | Total number of isolates | ESBL producers | Percentage |
|----------------------|--------------------------|----------------|------------|
| *Escherichia coli*   | 07                       | 06             | 85.71%     |
| *Klebsiella pneumoniae* | 04                      | 03             | 75%        |
| **TOTAL**            | 12                       | 09             | 75%        |

Total: 09 out of 12 Enterobacteriaceae (75%); *Escherichia coli*: 06 (66.67%); *Klebsiella pneumoniae*: 03 (33.33%)

Table.12 Antibiotic susceptibility pattern of *Pseudomonas aeruginosa*

| Antibiotics               | *Pseudomonas aeruginosa* (n=02) |
|---------------------------|---------------------------------|
| Amikacin                  | 100%                            |
| Gentamicin                | 100%                            |
| Tobramycin                | 100%                            |
| Ceftazidime               | 100%                            |
| Cefipime                  | 100%                            |
| Imipenem                  | 100%                            |
| Meropenem                 | 100%                            |
| Piperacillin-tazobactam   | 100%                            |
| Ciprofloxacin             | 100%                            |
| Levofloxacin              | 100%                            |

Fig.1 Age Distribution
Fig. 2 Presenting symptoms

Fig. 3 Correlation of Gram stain and culture
**Fig. 4** Aerobic bacterial profile of post-operative wound infection

**Fig. 5** Comparison of antibiotic sensitivity pattern of MSSA and MRSA
Fig. 6 Antibiotic susceptibility pattern of *E. coli* and *K. pneumoniae*

![Antibiotic Susceptibility Pattern](image)

**Presenting symptoms (Table 7, Figure 2)**

The most common presenting symptom in this study was purulent discharge (75.61%) followed by pain and tenderness (41.46%), fever (23.17%) and wound gaping (17.07%).

**Correlation of Gram stain and culture (Figure 3)**

More than half of the samples (59.76%) showed organisms in Gram Stain and in culture as well. 30.49% samples had no organisms in Gram stain and had no growth on aerobic culture. Our finding on culture positivity is similar to studies by Rahman et al., (2011) and Ramesh et al., (2012) who reported 65% and 66% culture positivity respectively. In the present study it was noticed that some patients were already receiving antibiotic therapy even before the sample was sent for culture. This might have led to the absence of organisms in Gram Stain and culture. A small percentage (9.76%) of the samples showed organisms in the smear which did not grow. The reason for this may be the presence of anaerobes which could not have grown on aerobic culture.

**Aerobic bacterial profile and antibiotic sensitivity pattern (Table 8, Figure 4)**

A total of 49 samples showed growth on aerobic culture. Among these *Staphylococcus aureus* was the predominant isolate (36 out of 49) accounting for 73.47%. This finding of Staphylococcal predominance is similar to other studies by Gupta (2012), Ramesh et al., (2012), and Khosravi et al., (2009). Proportion of MRSA in the present study was 77.78%. Over 75% of *S. aureus* were Methicillin resistant in studies by Gupta (2012), Mahesh et al., (2010) and Golia et al., (2014). Majority of *S. aureus* were isolated
from orthopaedic and gynaecological surgeries in our study. All the *Staphylococcus aureus* isolates showed 100% susceptibility to Linezolid and Vancomycin (Table 9). This finding is supported by Rao et al., (2013), Shahane et al., (2012) and Ranjan et al., (2013). Over 70% of the isolates were sensitive to Gentamicin, clindamycin, tetracycline and cotrimoxazole. Out of 10 Clindamycin resistant isolates, 3 showed inducible resistance (D test positive). All the three isolates were Methicillin sensitive.

When we compared the sensitivity patterns of MSSA and MRSA (Figure 5), we noticed that both showed maximum susceptibility to Linezolid and Vancomycin (100%) followed by Chloramphenicol (92.86% for MSSA and 87.5% for MRSA). Majority of MSSA were sensitive to erythromycin and clindamycin (64.29% and 89.29% respectively) whereas only 12.5% of MRSA were sensitive to these drugs. This finding of MRSA isolates being more drug resistant than MSSA is supported by Ranjan et al., (2013). Wassef et al., (2012) have also reported co-resistance of MRSA to tetracycline, clindamycin and Gentamicin in their study.

*Escherichia coli* was the second most common organism isolated in this study. Rahman et al., (2011), Sonawane et al., (2010) and Mawalla et al., (2011) also reported a similar finding. Maximum (100%) susceptibility was seen against Piperacillin-tazobactam, Imipenem and Meropenem followed by Amikacin (71.42%) and Chloramphenicol (57.14%). Least susceptibility was observed against Gentamicin and Levofloxacine (28.57% each); cephalosporins, ciprofloxacin and Cotrimoxazole (14.29% each) (Table 10). Similar antibiotic sensitivity pattern has been reported by Sonawane et al., (2010), Shah et al., (2015) and Golia et al., (2014).

*Klebsiella pneumoniae* was the third most common organism isolated accounting for 6.12%. This organism showed 100% susceptibility to Cotrimoxazole, Chloramphenicol, Piperacillin-tazobactam, Imipenem and Meropenem (Table 10, Figure 6). Only about a half of the isolates were sensitive to Amikacin. Like *E. coli*, *K. pneumoniae* also showed least susceptibility against cephalosporins, Gentamicin, ciprofloxacin and Levofloxacine (25% each). 75% of all isolates showed ESBL production. Sonawane et al., (2010) have reported a similar finding of antibiotic susceptibility pattern. However Verma et al., (2012) reported maximum susceptibility towards ceftriaxone (66.67%) in their study.

**ESBL producers (Table 11)**

ESBL production was seen in 9 of the 12 Enterobacteriaceae isolated accounting for 75%. Among these, 6 were *E. coli* and 3 were *K. pneumoniae* (66.67% and 33.33% respectively). Over 60 % of ESBL production has been noted by Shanthi et al., (2012), Wassef et al., (2012) and Mawalla et al., (2011).

There were 2 isolates of *P. aeruginosa* in the present studies which were 100% susceptible to all the antibiotics tested (Table 12). Over 83% susceptibility against Piperacillin-tazobactam, Ceftazidime and Imipenem has been reported by Shahane et al., (2012). Sonawane et al., (2010) also reported 80-90% sensitivity of *P. aeruginosa* against Piperacillin-tazobactam and Imipenem and higher percentage of resistance to all the other antibiotics tested.

Overall incidence of post-operative wound infections in the present study was 1.7%. The risk factors associated were Diabetes mellitus, hypertension, advanced age and multiparty. *S. aureus* was the predominant isolate followed
by *E. coli*, *K. pneumoniae*, *P. aeruginosa* and *P. mirabilis*. 22.22% of *S. aureus* were Methicillin resistant and also showed co-resistance to many of the commonly used antibiotics. Among the Enterobacteriaceae isolated, more than half of them were ESBL producers.

Reduction in the rate of post-operative wound infection is necessary to bring down the morbidity and mortality associated with it as well as to lower the wastage of healthcare resources, treatment cost and economical burden on the patient. Adequate glycaemic control in diabetic patients, proper antimicrobial prophylaxis, infection control measures, suitable antibiotic policy development, and surveillance are the most effective measures to reduce post-operative wound infections as well as emergence of multidrug resistant strains.

**Funding**

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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**How to cite this article:**

Preethishree, P., Rekha Rai and Vimal Kumar, K. 2017. Aerobic Bacterial Profile of Post-Operative Wound Infections and Their Antibiotic Susceptibility Pattern. *Int.J.Curr.Microbiol.App.Sci.* 6(9): 396-411. doi: https://doi.org/10.20546/ijcmas.2017.609.049