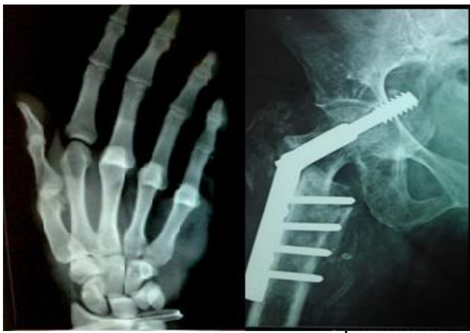

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A study on the microbial profile at surgical site with orthopedic implant in traumatic injuries and its associated risk factors at tertiary care hospital

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Abstract

Introduction: Study was conducted to identify the etiological agents of orthopedic implant infections in posttraumatic postoperative period. To identify the risk factors for orthopedic implant infection. To study the Antimicrobial susceptibility patterns of the isolates with a view to formulate an empiric antibiotic regimen.

Material and Methods: The study period was prospective study conducted January 2020 to December 2021. One hundred and fifty patients were investigated for early, intermediate and late post-operative infections of orthopedic bone implants using conventional microbiological procedures. Antimicrobial susceptibility testing was then performed for the isolated bacteria according to the standard guidelines.

Results: Out of 150 orthopedic post traumatic, postoperative implant infections, a total of 140 isolates had positive culture (138 aerobes and 2 anaerobes). Of the total 150 cases 80.66 % was mono microbial infection whereas 12.6% had poly microbial. *Staphylococcus aureus* is the most common organism isolated followed by *Pseudomonas* and *E.coli*. 60.2 % of *Staphylococcus aureus* and 73.52% of *Staphylococcus epidermidis* were found to be methicillin resistant. 85 % *Proteus* and 67.2% of *Escherichia coli* were found to be Extended Spectrum Beta-Lactamases (ESBL) producers. 60% of staphylococcus showed sensitivity to Vancomycin and Rifampin, 76.78 %, 66.96%, 49.10%, 42.84%, 46.42% to Linid, Tiecoplanin, Clindamycin, Meropenum and to Imipenum respectively. Whereas 68.7% of *Pseudomonas* showed sensitivity to collistin, 56.25% and 53.12 to Piptaz/Tazobactum and tobramycin respectively. 70.2% of staphylococcus, 40% of pseudomonas was sensitive to cephalosporins. Diabetes mellitus, compound injuries and longer duration of surgery were the important risk factors noted in our study. Diabetes was associated more with methicillin resistant staphylococcus aureus. There was no difference found in sensitivity pattern in stainless steel and titanium implant.

Conclusion: Prophylactic antibiotics should be started as per locally commonly observed organism and their sensitivity pattern to prevent infection.

Keywords: Microbial profile, traumatic injuries, risk factors

Introduction

Infections associated with orthopedic implant surgery are considered as a serious threat [1, 2]. Posttraumatic and postoperative infections leads to increase in morbidity and mortality rates, increased hospitalization costs due to extended hospital stay and spending on diagnostic and therapeutic procedures, besides distancing patients from their work and family [3, 4]. Surgical site infection (SSI) post internal fixation poses a large socioeconomic burden and quality of life implication for patients and can lead to complications as serious as loss of the operated limb and even death [3, 5, 6]

Infection can occur due to multiple extrinsic and intrinsic risk factors such as the patient's pre-operative condition, prolonged preoperative hospitalization, surgical time, skin preparation, surgical teams' hand washing technique, material of implants and sterilization techniques, among others [7-11]. Although incidence of orthopedic implant infection is now low – internationally <1-2%, even the slightest risk of infection can result in number of patients with orthopedic implant infection [12]. Orthopedic infections are important to evaluate as they have a high morbidity rate and a tendency to serious relapse [13].

Staphylococcus Aureus and *Staphylococcus Epidermidis* are the most common offending organisms, whereas *Streptococcus Viridans, Escherichia coli are less* frequently encountered. About one-third of these infections develop within 3 months, another third develop within 1 year and the remainders develop more than 1 year after surgery [14].

Though the bacterial profile from pus sample remains similar in various studies, but there is considerable variation in antibiotic sensitivity pattern, highlighting the emergence of resistance [15].

This study was conducted retrospectively to evaluate the clinical and etiological profile of orthopedic implant infections in trauma cases. It helps in providing the necessary information to formulate a local antibiotic policy by analyzing the various pathogens causing orthopedic implant infection and its sensitivity and/or resistance to various antibiotics.

Materials and Methods

This prospective study was conducted in over the period of 2 years from January 2020 to December 2021 at single specialty tertiary care hospital. Of the total 8137 patients operated over 2 years 150 cases were diagnosed with infection based on clinical features (pain, swelling and warmth of the joint, discharge and fever), together with one or more of the parameters: elevated ESR, elevated C-reactive protein and leukocytosis over 12,000 were included. Whereas patients coming to hospital with preexisting infection and have undergone more than one surgery for the same implant were excluded from the study. Also association of underlying illness (diabetes mellitus, uremia, chronic arthritis and concurrent urinary tract infection), type of implant, and duration of procedure were also studied in this study. Under strict aseptic precautions samples (Pus or Fragments of excised tissue removed or curetting from infected sinuses were collected and transported to the laboratory immediately. Every closed injury was given 2nd generation antibiotic night before operation and same day morning whereas compound injuries were given 2nd gen cephalosporin, Amikacin and Metronidazole were given preoperatively and 5 days post operatively.

Sample processing and interpretations are done by standard conventional microbiological techniques. Media and discs were tested for quality control using standard strains.

Results

Of 8137 patients who underwent orthopedic implant surgeries in a single specialty tertiary care hospital for fracture during this study period, 150 patients developed infection and were included in study. Among 150 infected patients, 117 (78%) were males and 33 (22%) were females. Out of 150 infections, the most common bone that was complicated with infection was femur in 56 patients (37.33%) followed by tibia in 53 patients (35.33%). There were more number of early postoperative infections (71%) found in this study, rather than intermediate (11%) and late chronic (18%). Common location associated with infection were roadside trauma contributing (65.33%) followed by factory (7.33%), home (19.33%), farm (6.06%). Total of 150 post traumatic injuries 38% were compound injuries and 62% were closed injuries. There were mainly 2 types of material used in surgeries titanium and stainless steel. 106(70.6 %) patients of 150 had stainless steel implant whereas 44 (29.4%) had titanium implant. Out of 8137 total patients operated over the period of 2 years stainless steel implant was used in 4960 patients (106/4960 – 2.13%) whereas titanium implant were used in 3177 patients (44/3177- 1.38%)

In this study, 48 patients of infected cases had Diabetes mellitus, 18% underwent surgery for more than 2.5 hours, 2 of which had malignancy. Apart from these proven risk factors, smoking and alcoholism were also noted in 39.25% and 42.87%, respectively.

Of the culture isolated mono microbial isolation was more common accounting for 80.66% whereas poly microbial infection accounting for 12.66%.

In the present study, *Staphylococcus* is the most common individual organism [98(65.3%)] isolated followed by *pseudomonas and E.coli* [19(12.66%) and 18(12%)] respectively. In further study of staphylococcus subspecies methicillin sensitive staphylococcus aureus (MSSA) was most commonly isolated in 59 (60%) samples followed by methicillin resistant staphylococcus aureus (MRSA) (23.46%), methicillin resistant coagulase negative staph (MR CONS) and staphylococcus hemolyticus (7.14%) each.

Of all the infected cases 14.67% (22) of patients was managed medical management without any surgical intervention whereas 86% of patients needed some form of surgical intervention after detecting of infection. Of this 32.67% needed 1 surgical intervention whereas 53.33% requiring more than 1.

Discussion

Orthopedic implant site infections continue to be a diagnostic and therapeutic challenge. It is much more complicated by the formation of biofilm leading to burden in antibiotic selection and prolonged antimicrobial therapy due to emergence of multidrug resistant pathogens. In this study of the 8137 patients who underwent orthopedic implant surgeries for fractures during study period, 150 patients developed infection. The rate of orthopedic implant in present study is 1.8%. Rate of infection varies from 5-10% as per various studies [17, 18, 19] High prevalence of infections in other study were may be related to advanced age group population, prolonged surgical time, smoking, skin abrasion, lack of adequate disinfection procedures, contamination of surgical instruments and /or contaminated implants. Whereas probable factors associate with our reduced infection rate were, (1) less frequent changing of operation theaters sterile dressing, (2) using tegaderm air tight dressing [19, 20], (3) hand scrubbing for 5 minutes [21], (4) appropriate prophylaxis antibiotics, (5) scrub bath before surgery with chlorhexadine [22], (6) clipping of hair just before surgery [23], (7) early postoperative mobilization and removal of catheter on day 1 so reduced urinary tract infection [24], (8) fortnightly culture and assistances hand. Every closed injury patient was given Cefuroxime Axetil previous night of surgery and same day early morning followed by twice a day for 5 postoperatively whereas compound injuries were given triple antibiotic in the form of Cefuroxime, Amikacin and Metronidazole pre surgery and 5 days after surgery. Amongst this 71% were early onset postoperative wound infections (<1 month after surgery); 11% under intermediate infection and 18 % under late chronic infection. Similar incidence has been observed in other studies showing 72.9%, 22.6% and 4.5% respectively [25].

Of all infected patients 71.8% of them had a significant proven risk factor, i.e., uncontrolled diabetes, prolonged surgery time (mean surgery time 2.5 hours) [26], tourniquet time >2 hours, compound injuries and other risk factor noted in 18%. Alcoholism and smoking were noted in 42.87 % and 39.25 % of the infected cases respectively**.** Also it has been noted that infected implants were more common in surgeries done in tibia and femur [femur (37.33%) > tibia (35.33%)] as compared to other areas but tibia and femur were maximum operated bone it was not statistically significant.

In this study, etiological agents of orthopedic implant infections were identified in 140 patients of whom 121 had mono microbial growth and 19 patients had poly microbial infection. So, in this study, mono microbial infections were more common than poly microbial infection. Poly microbial infection is more commonly seen in late infection, patients who had required multiple surgeries, older age group. And may be the reason why our study had less number of poly microbial infection [5].

According to the present study, cultures were positive in majority of the studied patients (93.32%).This finding is similar to the observations of other studies which showed 93.9% [25] and 89% [27]. In the present study, aerobic Gram positive cocci were isolated in 65.33%, aerobic gram negative bacilli in 33.92% and anaerobic gram positive cocci in 1.32% of the positive cultures. This is in accordance with the data given by studies which showed gram positive cocci ranging from 65-76% [28].

Of the 140 culture positive cases, *Staphylococcus aureus* was the most common pathogen isolated 83 (59.28%) followed by *pseudomonas aeuruginosa* 19 (12.66%) and *E.coli* in 12% of cases. (Figure no. 1) Other studies showed similar result of staphylococcus aureus being most common [7, 24, 27]. Polysaccharide intercellular adhesion (PIA) has been found in many S. aureus strains and is required for biofilm formation and bacterium-bacterium adhesion. This is responsible for biofilm formation resulting in resistance to various drugs.

Staphylococcus aureus showed 60% sensitivity to Vancomycin and Rifampin, 76.78 % to Linid, 66.96 % to Tiecoplanin, 49.10 % to Clindamycin, 42.84 to Meropenum and 46.42 % to Imipenum, 80% to cephalosporin. Other similar studies have shown sensitivity pattern to Linind and Vancomycin to be 95-100%, 55-60% to Imipenum 25-30% to clindamycin and 32-40 % to tetracycline [15, 19] (Figure no.2).These MRSA and Methicillin Resistant *Staphylococcus Epidermidis* were more commonly isolated from early onset postoperative infection than intermediate and late chronic infections. This indicates that use of inadequate antibiotics during empirical therapy and longer duration of hospitalization may selectively enhance the growth of drug resistant pathogens. In spite of this sensitivity pattern to Vancomycin, patients don't responded well clinically. This may be explained by need of biofilm elimination concentration which is much higher than MIC and poor penetration of Vancomycin into the biofilm.

Among gram-negative isolates, *Pseudomonas* was the most common isolate which showed 68.7% sensitivity to Collistin, 56.25 % to Piptaz/ Tazobactum, 53.12% to tobramycin, 63.2% to cephalosporin. Other studies have suggested similar sensitivity pattern where pseudomonas where sensitivity for Collistin varies from 70-78%, 65-80% to Amikacin, 60-80% to tobramycin,80-100% to Meropenum/ Imipenum, whereas Piptaz/Tazobactum sensitivity pattern ranged from 45-78% [15, 19]. (Figure no.5)

E.coli was 3rd most common organism isolated which showed 88 % sensitivity to Collistin, 70% to Meropenum and Imipenum, 68% to Amikacin, 76% to cephalosporin.(Figure no.5) Other studies have shown similar result in sensitivity pattern where sensitivity of Collistin ranges from 80-85%, Imipenum and Meropenum ranging from 75-92%, Piptaz / Tazo ranging from 70-90% [15, 19].

Compound injuries were associated with 54 % of times with MRSA which was only 20% with closed injuries.results were similar to other studies which showed association with MRSA ranging from 40-70% [15, 19].

Among the mechanisms of resistance to 3rd generation of cephalosporis, production of ESBL is most common. 20% of pseudomonas was found to be Metallo beta lactamase (MBL) producers and 85% of proteus was found to be ESBL producer. Amongst all isolate of *E.coli* 67.2% were found to be ESBL producer by screening test.

Amongst all diabetic patients developing infection MRSA was most common affecting organism and it was most sensitive to Linid (Figure no.6)

From results we observed that amoxicillin/clavulanic acid, ceftrixaone and ceftazidime cannot be recommended for use as an empirical therapy in SSI and open fracture infections because these drugs were inactive against most strains. Based on the antimicrobial susceptibility data, we suggest that piperacillin/tazobactum and imipenem are the most effective agents against most of gram negative bacteria and vancomycin, linezolid are the most effective agents against gram positive organisms. Colistin and tigecyclin showed 90% sensitivity by all gram negative bacteria, but these drugs are kept as reserve, should be used judiciously [29]

Conclusion

The infection rate in our study was lower as compared to other studies. There is need for proper measures of infection control as it has great financial burden on patient and on hospital resources and could lead to increased morbidity and mortality in patients. Diabetes mellitus, compound trauma and prolonged duration of surgery were the three important risk factors associated with infected cases in our study. The choice of empiric antibiotics should be based both on local pathogen prevalence and antimicrobial susceptibility pattern. Giving Linid to diabetic patient as prophylactic may reduce infection rate in them. In future a more comprehensive study with a long follow up period is needed to develop a good treatment protocol for orthopedic implant infection and also to create a good protocol for prevention of orthopedic implant infections.

Charts and figures

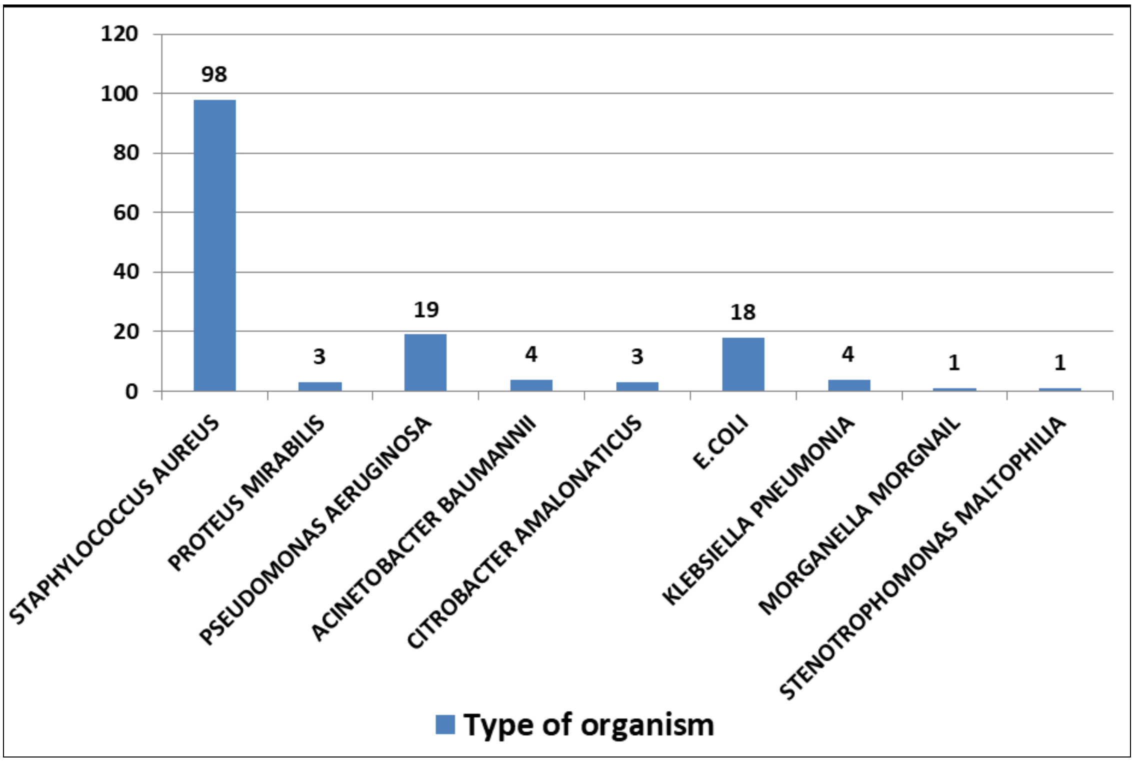

Fig 1: Most common organism isolated

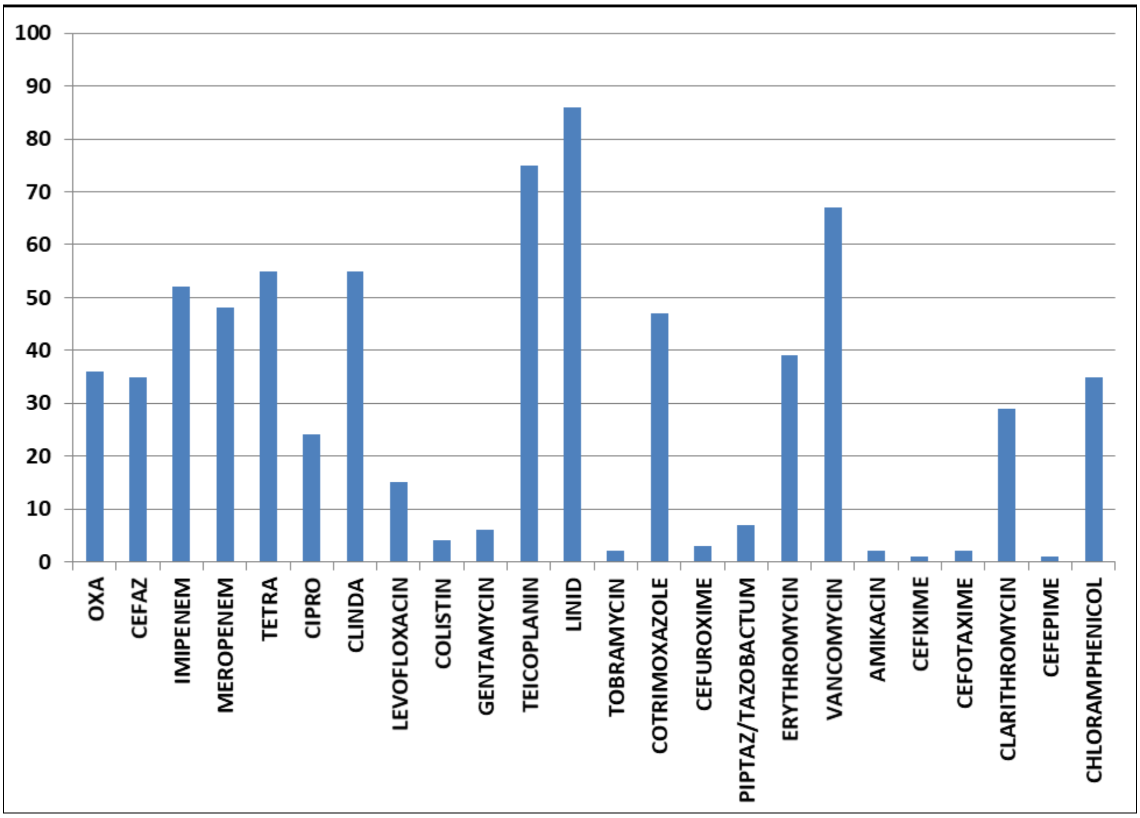

Fig 2: Sensitivity of staphylococcus

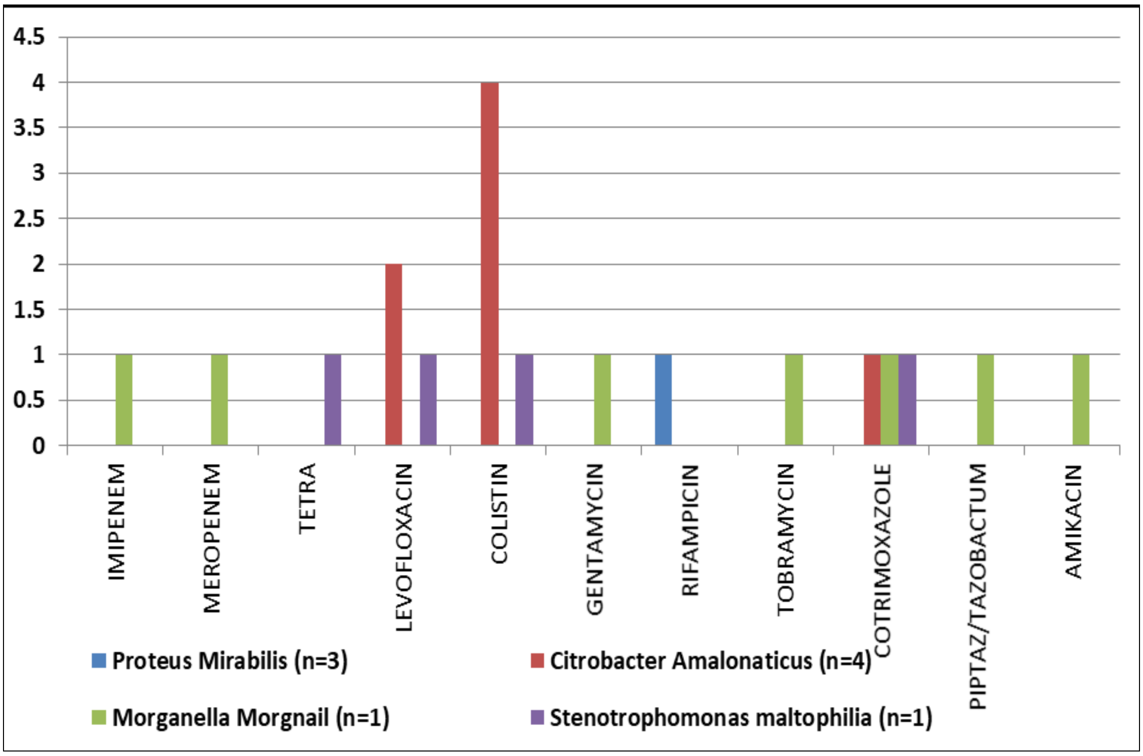

Fig 3: Sensitivity patterns of Proteus, Citrobacter, Morganella and Stenotrophomonas

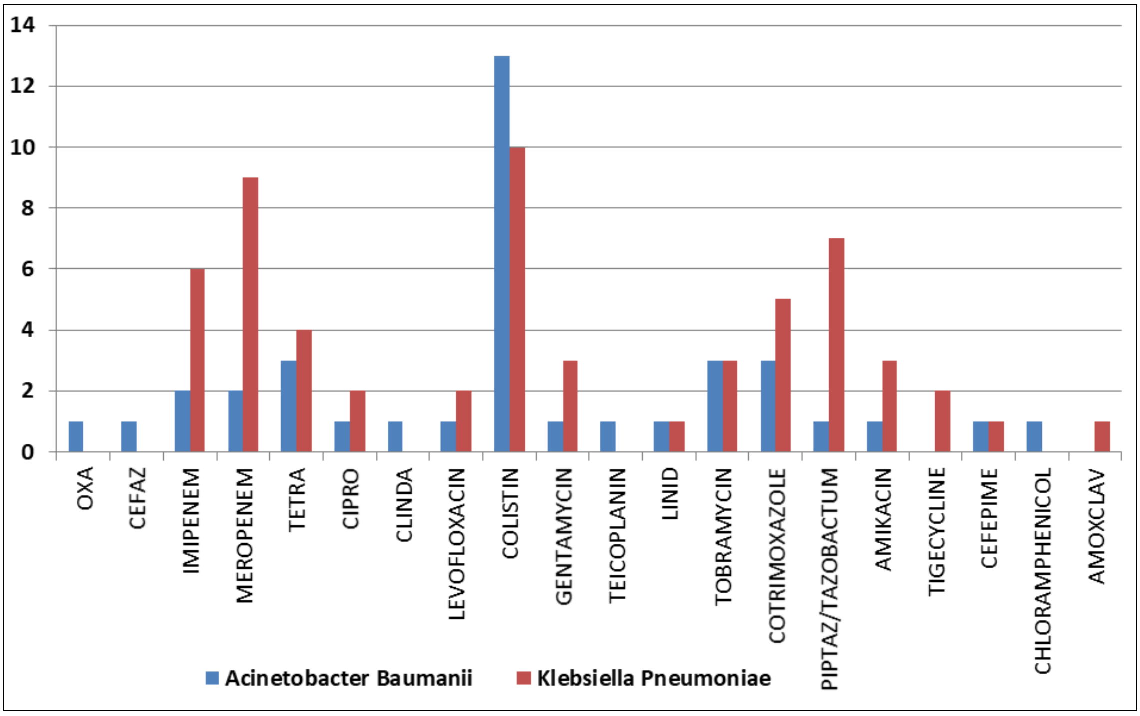

Fig 4: Sensitivity patterns of Acinetobacter and Klebsiella

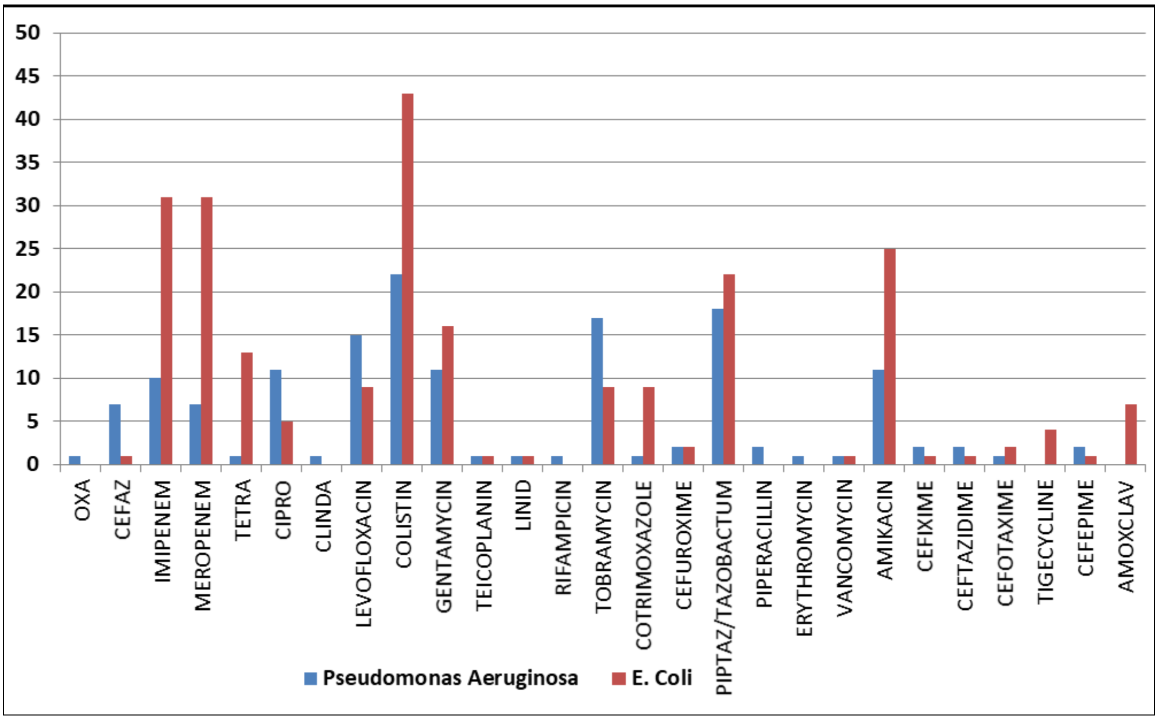

Fig 5: Sensitivity patterns of Pseudomonas and *E. Coli*

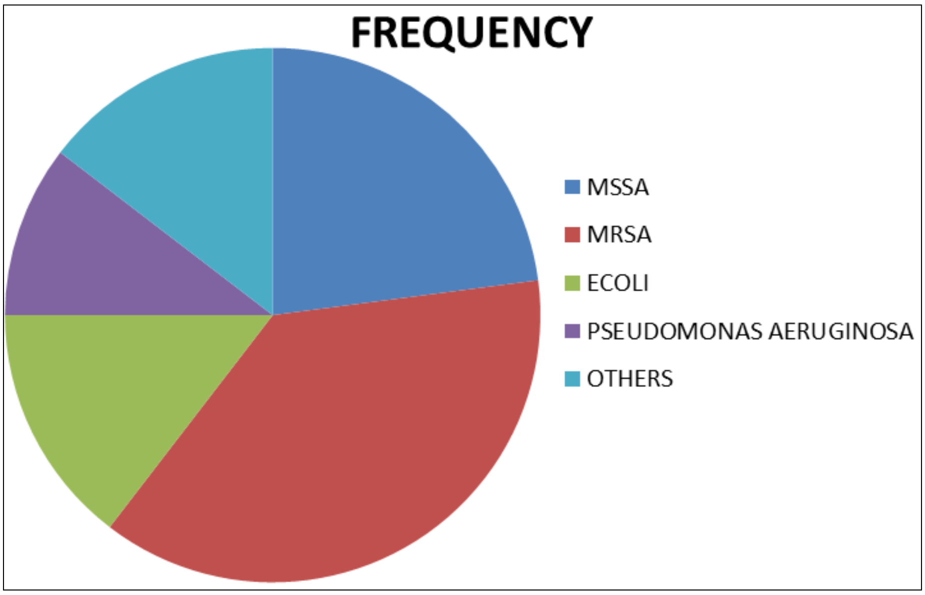

Fig 6: Common organism associated with diabetic patients.

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