VOLUME - 12, ISSUE - 02, FEBRUARY - 2023 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Orthopaedics

# BACTERIOLOGICAL PROFILE AND THEIR SENSITIVITY PATTERN OF ANTIBIOTICS TO POST-OPERATIVE ORTHOPAEDIC IMPLANT INFECTIONS IN TERTIARY CARE HOSPITAL

| | |
|---|---|
| **Dr Ganja Ravi Kumar** | 3rd yr Post Graduate, Orthopaedics |
| **Dr Jaladi Syam Priya** | 3rd yr Post Graduate, Orthopaedics |
| **Dr Phanendra Godavarthi** | 3rdyr Post Graduate, Orthopaedics |
| **Dr R. Sri Teja*** | Assistant Professor, Orthopaedics *Corresponding Author |

**ABSTRACT**

**Background:** A correct information about most common causative organism and it sensitivity pattern in that clinical setup is essential for designing empirical therapy. Present study has been designed to study the microbiological profile and antibiotic sensitivity pattern of post-operative orthopaedic Implant infections in tertiary care teaching hospital. **Material and Method:** This prospective observational study. Patients who presented with the signs and symptoms of infections, confirmed by laboratory and other routine investigations, were included in present study. The demography, microbiological data sensitivity to antimicrobial agent of organism was recorded. **Result:** The most common pathogen isolated was pseudomonas aeruginosa that is 37 (41.1%), followed by staphylococcus aureus that is 36 (40%). Pseudomonas aeruginosa was sensitive to Piperacillin tazobactam 28(77.7%), Imipenem 26(72.2%), Imipenem+cilastatin 28(77.7%) and Meropenem 30(83.3%). Methicillin resistant staph aureus were sensitive to Cotrimoxazole 4(44.4%), Clindamycine 6(66.6%), Vancomycin 8(88.8%) and Linazolid 7(77.7%). **Conclusion:** Implant of femur was most commonly infected. Staphylococcus Aureus (MSSA) was commonly associated with biofilm formation followed by Staphylococcus Aureus (MRSA). Pseudomonas aeruginosa isolated from implant infections were sensitive to Piperacillin+ tazobactam, Imipenem, Imipenem+cilastatin and Meropenem.

**KEYWORDS :** Orthopaedic implant infections, antibiotic sensitivity, bacteriological profile

## INTRODUCTION

Implants in orthopaedics surgery are mainly used to restore the function of load-bearing joints and decrease the pain so that patients can be mobilised early and duration of stay in hospital can be reduced. Implant related infection is major problem which leads to implant failure [1, 2]. It is a type of surgical site infections (SSIs) that can double the length of time a patient stays in hospital, significantly increase healthcare expenditure and in severe cases it may lead to amputation and mortality [3]. Implant-associated infections are the result of adhesion of bacteria to implant surface and subsequent biofilm formation at the implantation site. Once biofilm is formed it is difficult by host defence and ordinary antimicrobial therapy to remove it [4, 5]. The incidence of implant infection in elective orthopaedic surgery is in the range of 0.7% to 4.2% [6, 7]. Mundhada AS, Tenpe S *et al*. has reported that orthopaedic implant infection in India is 6 % [8]. In spite of availability of good aseptic operation theatre, rational preoperative antibiotic prophylaxis and global guidelines for the prevention of surgical site infection, implant related infections are common [9]. A correct information about most common causative organism and it sensitivity pattern in that clinical setup is essential for designing empirical therapy.

From literature survey we have found that there is diversity in the conclusion of various researchers about causative organism and it susceptibility to anti-microbial agent. Mousa HA *et al*. from Iraq has concluded that Pseudomonas aeruginosa and Staphylococcus epidermidis were the most common causative agents [10]. Abulfotooh M Eid *et al*. from Egyptian has concluded that Staphylococci, both coagulase positive and coagulase negative (epidermis), constitute the majority of the offending organisms [11]. Fernandes A, Dias M from India has concluded that Staphylococcus SPP are the commonest isolates [12].

Present study has been designed to study the microbiological profile and antibiotic sensitivity pattern of post-operative orthopaedic Implant infections in tertiary care teaching hospital.

## MATERIAL AND METHOD

This prospective observational study was carried out in the Department of orthopaedics and department of Microbiology, at Konaseema institute of medical science Amalapuram A.P. India, for a period of two years, from September 2020-October 2022.

### Ethics:

Approval from institutional ethics committee was taken before start of study. A written informed consent was obtained from all patients before enrolling them for study.

### Selection of patients

The patients admitted in the department of orthopaedics for implant or prosthesis surgery, who presented with the signs and symptoms of infections, confirmed by laboratory and other routine investigations, were included in present study. The specimens having polymicrobial flora were excluded from study.

### Sample size:

As per selection criteria 90 patients were enrolled for this study.

## METHOD

With all aseptic precautions sample was collected from the secretions of the infected orthopaedic wounds by using a sterile cotton swab and a sterile disposable syringe. The sample collected was immediately transported to the laboratory for culture and antibiotic sensitivity testing. Gram staining and acid fast staining of all samples were done. For isolation of aerobic bacteria the sample was inoculated blood agar and MacConkey agar. The media was incubated at 37$^0$C for 24 to 48 hours. For isolation of anaerobic bacteria the sample was inoculated in Robertson's cooked meat broth. A

standard microbiological procedure was used for identification of isolates. Kirby Bauer method was used for attesting antimicrobial susceptibility of isolates by using guidelines of the Clinical and Laboratory Standards Institute[13].

Tissue culture plate method and the Tube method was used for the detection of bacteriological biofilm detection as described by Manandhar, S., Singh, A., Varma, A. *et al*. and Mathur T, Singhal S, Khan S, Upadhyay DJ, Fatma T, Rattan A *et al*. [14, 15]. Statistical analysis: Data were recorded in excel sheet and statistical Analysis was done with software SPSS-14 version. Data were calculated as percentage and proportions.

## RESULTS

As per selection criteria 90 culture positive patients were enrolled for this study. The mean age of the patients was 44.90 ± 16.30 years and there was male predominance. Most of the patients were between 30 to 60 years of age. (Table 1)

**Table 1: Demography of patients**

| AGE (years) | NUMBER OF PATIENTS |
|---|---|
| Below 30 | 4 |
| 31 to 60 | 60 |
| Above 60 | 26 |
| MALE / FEMALE | 60 / 30 |

The most common pathogen isolated was pseudomonas aeruginosa that is 37(41.1%), followed by staphylococcus aureus that is 36(40%). Among 36 Staphylococcus aureus, n=8 (8.8%) of the isolates were found to be MRSA (Methicillin resistant Staphylococcus aureus) and 28 isolates were MSSA (Methicillin sensitive Staphylococcus aureus). Klebsiella SPP was isolated in 7 patients and *E.coli* was isolated in 6(6.6%). Enterococcus Spp was isolated in 4(4.4%) patients. (Table 2)

**Table 2: Microbiological profile of pathogen isolated**

| Organism isolated | Number (%) |
|---|---|
| Pseudomonas aeruginosa | 37 (41.1%) |
| Staphylococcus Aureus | 28 (31.1%) |
| Staphylococcus Aureus(MRSA) | 8 (8.8%) |
| Klebsiella SPP | 7 (7.7%) |
| E. Coli | 6 (6.6%) |
| Enterococcus SPP | 4 (4.4%) |
| Anaerobes | 0 |

Femur was the most common site effected 31(34.4%) which was followed by tibia in 17(18.8%). Foot was affected in 11.1% and ulna was least commonly affected(table 3)

**Table 3: frequency of pathogen isolated and site of infection**

| Site of infection | Number |
|---|---|
| Femur | 31 |
| Tibia | 17 |
| Foot | 10 |
| Humerus | 10 |
| Knee | 9 |
| Radius | 8 |
| Ulna | 5 |

In present study, 15 isolates showed biofilm production by the Tissue Culture Plate Method. They required extensive antimicrobial therapy and in some implant was removed to cure infection. Staphylococcus Aureus (MSSA) was commonly associated with biofilm formation followed by Staphylococcus Aureus (MRSA). Klebsiella SPP was 13.3% of total isolate. Enterococcus SPP was also 6.6% of total isolate.

**Table 4: Biofilm producing organism**

| Organism | Number |
|---|---|
| Staphylococcus Aureus | 8 |
| Staphylococcus Aureus(MRSA) | 4 |
| Klebsiella SPP | 2 |
| Enterococcus SPP | 1 |

**Table 5: Antimicrobial susceptibility patterns organism isolated**

| Antimicrobial Agent | Organism isolated | | | | | |
|---|---|---|---|---|---|---|
| | pseudomonas aeruginosa | Staphylococcus Aureus | Staphylococcus Aureus (MRSA) | Klebsiella SPP | E.coli | Enterococcus SPP |
| Cotrimoxazole | 1 (2.7%) | - | 4(44.4%) | 3(42.8%) | 1(16.6%) | 2(50%) |
| Amoxicillin+clavulanic acid | - | 15 (53.5%) | - | 1(14.2%) | 2(33.3%) | 3(75%) |
| Ampicillin+sulbactam | - | - | - | 2(28.4%) | 1(16.6%) | 2(50%) |
| Piperacillin tazobactam | 28 (77.7%) | - | - | - | 6(100%) | 4 (100%) |
| Imipenem | 26 (72.2%) | - | - | 6(85.7%) | 5(83.3%) | - |
| Imipenem+cilastatin | 28 (77.7%) | - | - | 6(85.7%) | 5(83.3%) | - |
| Meropenem | 30 (83.3%) | - | - | 7(100%) | - | - |
| Cefixime | - | 3(10.7%) | - | 1(14.2%) | - | - |
| Ceftriaxone | 3(8.33%) | 7 (28%) | 1(11.1%) | 1(14.2%) | 2(33.3%) | - |
| Cefoperazone+sulbactam | 10 (27.7%) | 9(32.1%) | - | 5(71.4%) | 4(66.6%) | - |
| Ceftazidime | 11 (30.5%) | - | - | - | - | - |
| Cefipime | 20 ( 55.5%) | 22 (78.5%) | - | 6(85.7%) | 5(83.3%) | - |
| ciprofloxacin | 11 (27.7%) | 8(28.5%) | 1(11.1%) | 4(57.2%) | 2(33.3%) | 2(50%) |
| ofloxacin | 15 (41.6%) | 11 (39.3%) | 1(11.1%) | 5(71.4%) | 4(66.6%) | 2(50%) |
| Tetracycline | - | - | - | | 1(16.6%) | |
| Gentamycin | 14 (38.8%) | - | - | | 3(50%) | 2(50%) |
| Amikacin | 19 (52.7%) | - | - | | 6(100%) | 4(100%) |
| Tobramycin | 20 (55.5%) | - | - | | - | 4(100%) |
| Azithromycin | 3 (8.3%) | 12 (42.8%) | 3(33.3%) | 6(85.7%) | - | 1(25%) |
| Clarithromycin | - | 13 (46.4%) | 2(22.2%) | 5(71.4%) | - | 1(25%) |
| Clindamycin | - | 21 ( 75%) | 6(66.6%) | 7(100%) | - | - |
| Vancomycin | 8(22.2%) | 23 (82.1%) | 8(88.8%) | - | - | 4(100%) |
| Linazolid | - | 18 (64.2%) | 7(77.7%) | - | - | 3(75%) |

Pseudomonas aeruginosa was sensitive to Piperacillin tazobactam 28(77.7%), Imipenem 26(72.2%), Imipenem+cilastatin 28(77.7%) and Meropenem 30(83.3%). Staph aureus was sensitive to Cefipime 22(78.5%), clindamycine 21(75%), Vancomycin 23(82.1%) and linazolid 18(64.2%). Methicillin resistant staph aureus were sensitive to Cotrimoxazole 4(44.4%), Clindamycine 6(66.6%),Vancomycin 8(88.8%) and Linazolid 7(77.7%). Klebsiella Spp was 85.7% sensitive to Imipenem, Imipenem+cilastatin, 100% to Meropenem and Clindamycine. *E.coli* was 100 % sensitive to Piperacillin

tazobactam and amikacin 83.3% Imipenem+cilastatin, Cefipime. E coli were less sensitive to Cefoperazone+ sulbactam, ofloxacin and Gentamycin. Enterococcus Spp was highly sensitive to Piperacillin tazobactam, Amikacin, Tobramycin, Vancomycin and linazolid. It was sensitive to fluoroquinolones as well.

## DISCUSSION

Orthopaedic and trauma device-related infection is a major problem in orthopaedics leading to implant failure. Despite of best sterilisation and infection control practice device-related infection are common [16, 17]. Orthopaedic Implant infections continue to be an important patient safety problem and increase the financial and social costs to the patients [18].

In present study mean age of the patients were 44.6 $\pm$ 16.3 years and there was male predominance this finding is similar to the study of Benazir *et al*. and Sarangi Samir K, Padhi Sanghamitra *et al*. [19, 20].

The most common pathogen isolated was pseudomonas aeruginosa that is 37(41.1%), followed by staphylococcus aureus that is 36(40%). Mousa HA *et al*. has reported that from his study that Pseudomonas aeruginosa and Staphylococcus epidermidis were the most common causative agents which support our study [10]. Sarangi Samir K, Padhi Sanghamitra has reported that Staphylococcus aureus was found to be the most common aerobic isolate (31.1%) followed by Pseudomonas aeruginosa which corroborated with our study [20]. A Deny, C. Loiez, V et a.l has reported that patients who had undergone bone fixation had a lower rate of MRSA infections than patients, who had undergone arthroplasty 13% vs. 30% [21]. Muley VA, Ghadage DP et has reported that rate of MRSA isolation in his study was 12% [22]. This two study support our study that is 9% of total isolate. Latha T, Manjunatha H, *et al*. has reported that 57.3% of *Staphylococcus aureus* as MRSA which does not support our study [23]. Klebsiella Spp was isolated in 7 patients and *E.coli* was isolated in 6(6.6%) this finding is supported by the work of Chouhan V. Qivas *et al*. and Pfang BG, García-Cañete J, García-Lasheras J, *et al*. [24, 25]. Enterococcus SPP was isolated in 4.4% patient, which is supported by the work of Andreas F. Widmer *et al*. [26].

Implants in femur and tibia are most commonly infected. Implants in foot, humerus and knee are equally infected which is supported by the work of Fernandes A, Dias M. *et al*. [12]. Biofilm formation by organism is a complex process. This biofilm is responsible for chronic infection, resistant to treatment with antibiotics and a chronic inflammatory response at the site of the biofilm [1]. In present study Staphylococcus Aureus (MRSA) was commonly associated with biofilm formation followed by Staphylococcus Aureus (MSSA) which corroborates with the study of Choong PF, Dowsey MM, Carr D, Daffy J, Stanley P *et al*. and Teterycz D, Ferry T, Lew D, Stern R, Assal M, Hoffmeyer P, *et al*. [27, 28].

Regarding antimicrobial susceptibility patterns organism pseudomonas aeruginosa isolated from implant infections were sensitive to Piperacillin+ tazobactam, Imipenem, Imipenem+cilastatin and Meropenem. Among aminoglycosides sensitivity to Tobramycin was high in comparison to amikacin and Gentamycin. Among cephalosporin, 55.5% of isolated pseudomonas aeruginosa were sensitive to Cefipime, sensitivity to quinolones were less. This finding corroborates with the study of Perumal A, Kumar CA, and Doris TS *et al*. [29]. Staphylococcus aureus was sensitive to Cefipime, clindamycine, Vancomycin and linazolid. Sensitivity staphylococcus aureus to Amoxicillin+ clavulanic acid, Azithromycin and clarithromycin was around 50 % which is supported by the work of Shekhar Pal, Ashutosh Sayana, Anil Joshi, Deepak Juyal *et al*. {30}. In our study staphylococcus aureus (MRSA) are sensitive to clindamycine, Vancomycin and linazolid and Cotrimoxazole. This finding corroborates with the study of Latha T, Anil B, Manjunatha H, *et al*. and Tandra Chadha, Syeda Nazia Kulsum *et al*. [23, 31]. Study of Gitau, W., Masika, M., Musyoki, M. et a and Jain S, Chowdhury R, Datta M, Chowdhury G, Mukhopadhyay AK *et al*. supports our finding [32, 33]. Klebsiella Spp was highly sensitive to Imipenem, Imipenem+cilastatin, Meropenem Cefipime and Clindamycine. This is supported by the work of Raquel Silva, MD, Mauro Costa Salles *et al*. [34]. *E.coli* was sensitive to Piperacillin tazobactam, Imipenem+cilastatin, Cefipime and amikacin but less sensitive to Cefoperazone+ sulbactam, ofloxacin and Gentamycin. Study of Benazir *et al*. corroborates with our finding [35]. Enterococcus Spp was highly sensitive to Piperacillin tazobactam, Amikacin, Tobramycin, Vancomycin and linazolid but biofilm forming Enterococcus Spp was difficult to treat. Rasouli MR, Tripathi MS *et al*. has concluded that Management of Enterococcus PJI is challenging and multiple operations may need to be performed to control the infection [36]. Holmberg A, Mörgelin M *et al*. has concluded that ciprofloxacin or linazolid with rifampicin have a good effect on Enterococcus Spp which support our study [37]. E.Tornero, E.Senneville *et al*. has reported that failure of treatment was less with linazolid and Vancomycin which again support our study [38].

## CONCLUSION

From this study we can conclude that the most common pathogen isolated from post-operative orthopaedic Implant infections was pseudomonas aeruginosa. Implant of femur was most commonly infected. Staphylococcus Aureus (MSSA) was commonly associated with biofilm formation followed by Staphylococcus Aureus (MRSA). Pseudomonas aeruginosa isolated from implant infections were sensitive to Piperacillin+ tazobactam, Imipenem, Imipenem+cilastatin and Meropenem. Staphylococcus aureus was sensitive to Cefipime, clindamycine, Vancomycin and linazolid. Staphylococcus aureus (MRSA) are sensitive to clindamycine, Vancomycin and linazolid and Cotrimoxazole(44.4%). Klebsiella Spp was sensitive to Imipenem, Imipenem+ cilastatin, Meropenem Cefipime and Clindamycine. *E.coli* was sensitive to Piperacillin tazobactam, Imipenem+ cilastatin, Cefipime and amikacin. Enterococcus Spp was highly sensitive to Piperacillin tazobactam, Amikacin, Tobramycin, Vancomycin and linazolid.

## REFERENCES


1. Ribeiro M, Monteiro FJ, Ferraz MP. Infection of orthopedic implants with emphasis on bacterial adhesion process and techniques used in studying bacterial- material interactions. Biomatter 2012;2(4):176-194.doi: 10. 4161/ biom.22905.
2. Moriarty TF, Kuehl R, Coenye T *et al*. Orthopaedic device-related infection: current and future interventions for improved prevention and treatment. EFORT Open Rev 2017;1(4):89-99. Published. doi:10.1302/2058- 5241. 1. 000037
3. National Collaborating Centre for Women's and Children's Health (UK). Surgical Site Infection: Prevention and Treatment of Surgical Site Infection. London: RCOG Press 2008.
4. Campoccia D, Montanaro L, Arciola CR. The significance of infection related to orthopedic devices and issues of antibiotic resistance. Biomaterials 2006;27:2331-9. doi: 10.1016/j.biomaterials.2005.11.044.
5. Trampuz A, Osmon DR, Hanssen AD, Steckelberg JM, Patel R. Molecular and antibiofilm approaches to prosthetic joint infection. Clin Orthop Relat Res 2003;414:69-88. doi:
6. Zimmerli W, Trampuz A, Ochsner PE. Prosthetic-joint infections. N Engl J Med 2004;351:1645-54.
7. Kurtz SM, Lau E, Schmier J *et al*. Infection in hip and knee arthroplasty in the United States. J Arthroplasty 2008;23:984-91.
8. Mundhada AS, Tenpe S. A study of organisms causing surgical site infections and their antimicrobial susceptibility in a tertiary care hospital, Indian J Pathol Microbiol 2015;58:195-200.
9. Global guidelines for prevention of surgical site infection,WHO https://apps.who.int/iris/bitstream/handle/10665/250680/ 9789241549882-eng.pdf?sequence=8
10. Mousa HA. Infection following orthopaedic implants and bone surgery, East Mediterr Health J 2001;7(4-5):738-743.
11. Abulfotooh M. Eid the Egyptian orthopaedics Journal. Infected orthopedic implants. 2016;51(3):187-198.
12. Fernandes A, Dias M. The Microbiological Profiles of Infected Prosthetic Implants with an Emphasis on the Organisms which Form Biofilms. J Clin

Diagn Res 2013;7(2):219-223. doi:10.7860/JCDR/2013/4533.2732.
13. Humphries RM, Ambler J, Mitchell SL *et al*. CLSI Methods Development and Standardization Working Group Best Practices for Evaluation of Antimicrobial Susceptibility Tests. J Clin Microbiol 2018;56(4)
14. Manandhar S, Singh A, Varma A *et al*. Evaluation of methods to detect in vitro biofilm formation by staphylococcal clinical isolates. BMC Res Notes 2018;11:714. https://doi.org/10.1186/s13104-018-3820-9.
15. Mathur T, Singhal S, Khan S, Upadhyay DJ, Fatma T, Rattan A. An evaluation of three different screening methods. Indian J Med Microbiol 2006;24:25-29.
16. Moriarty TF, Kuehl R, Coenye T *et al*. Orthopaedic device-related infection: current and future interventions for improved prevention and treatment. EFORT Open Rev 2017;1(4):89-99.doi:10.1302/2058- 5241.1.000037
17. Tsaras G, Osmon DR, Mabry T *et al*. Incidence, secular trends, outcomes of prosthetic joint infection, olmsted county, Minnesota,
18. Poultsides LA, Liaropoulos LL, Malizos KN. The socioeconomic impact of musculoskeletal infections. J Bone Joint Surgery [Am] 2010;92:e13.
19. Benazir *et al*. Identification, Antibiotic Susceptibility Patterns and Biofilm Detection of Isolates in Orthopaedic Implant Infections; 2018;25(5):1-12. Article no.JAMMR.38988.
20. Sarangi Samir K, Padhi Sanghamitra Bacteriological profile of post-operative orthopedic implant infections and their antibiotic sensitivity pattern in a tertiary care hospital of southern Odisha,J NTR univ health sci 2019;8(2):114-117.
21. Deny A, Loiez C, Deken V, Putman S, Duhamel A, Girard J *et al*. Migaud Différences épidémiologiques entre les patients infectés sur matériel orthopédique par Staphylococcus aureus résistant ou non à la méticilline. Étude rétrospective sur une série continue de 115 patients,Revue de Chirurgie Orthopédique et Traumatologique 2016;102(7):663-667.
22. Muley VA, Ghadage DP, Bhore AV. Bacteriological Profile of Neonatal Septicemia in a Tertiary Care Hospital from Western India. J Glob Infect Dis 2015;7(6):75-77.
23. Latha T, Anil B, Manjunatha H *et al*. MRSA: the leading pathogen of orthopedic infection in a tertiary care hospital, South India. Afr Health Sci 2019;19(1):1393- 1401. doi:10.4314/ahs.v19i1.12
24. Chouhan V. Qivas Therapy for Treatment of Implant Associated MDR Bacterial Infection. J Orthop Case Rep 2016;6(2):69-71. doi:10.13107/jocr.2250-0685.440.
25. Pfang BG, García-Cañete J, García-Lasheras J *et al*. Orthopedic Implant-Associated Infection by Multidrug Resistant Enterobacteriaceae. J Clin Med 2019;8(2):220. Published. doi:10.3390/jcm8020220
26. Andreas F. Widmer, New Developments in Diagnosis and Treatment of Infection in Orthopedic Implants, Clinical Infectious Diseases 2001;33(2):S94- S106, https://doi.org/10.1086/321863.
27. Choong PF, Dowsey MM, Carr D, Daffy J, Stanley P. Risk factors associated with acute hip prosthetic joint infections and outcome of treatment with a rifampinbased regimen. Acta Orthop 2007;78(6):755-765.
28. Teterycz D, Ferry T, Lew D, Stern R, Assal M, Hoffmeyer P *et al*. Outcome of orthopedic implant infections due to different staphylococci. Int J Infect Dis 2010;14:e913-8. doi: 10.1016/j.ijid.2010.05.014.
29. Perumal A, Kumar CA, Doris TS, A study on the microbial profile of orthopedic implant infections and its risk factors in a tertiary care hospital, Indian J Microbiol Res 2016;3(4):412-418.
30. Shekhar Pal, Ashutosh Sayana, Anil Joshi, Deepak Juyal. Staphylococcus aureus: A predominant cause of surgical site infections in a rural setup of Uttarakhand: journal of family medicine and primary care 2019;8(11):3600-3606.
31. Tandra Chadha, Syeda Nazia Kulsum, Shashikant Adlekha, Prabhakar C Mailapur Comparison of antibiotic susceptibility pattern of community- and hospital- acquired methicillin-resistant Staphylococcus aureus to clindamycin resistance in a tertiary hospital in southern medical journal of Dr. D Y Patil vidyapith India 2014;7(4):439-442.
32. Gitau, W., Masika, M., Musyoki, M. *et al*. Antimicrobial susceptibility pattern of Staphylococcus aureus isolates from clinical specimens at Kenyatta National Hospital. BMCNotes 2018;11:226. https://doi.org/10.1186/s13104-018-3337-2
33. Jain S, Chowdhury R, Datta M, Chowdhury G, Mukhopadhyay AK. Characterization of the clonal profile of MRSA isolated from patients with early post-operative orthopedic implant based infections. Ann Clin Microbiol Antimicrob2019;18(1):. doi:10.1186/s12941-019-0307-z
34. Raquel Silva, MD, Mauro Costa Salles, MD, Roberta Matosa, Nurse, Bernardo Ayres, MD, Viviane Dias, MD, Luciana M Caetano, MD: The Worrisome Impact of *Acinetobacter baumannii* Multidrug Resistance in a Brazilian Center, Open Forum Infectious Diseases 2017;4(1):S111-S112.
35. Shazia Benazir, Dalip Kakru K, Syed Khurshid, Asifa Bhat, Umar Nazir, Shaista Nazir, Naseer A. Mir and Lenah Bashir, Identification, Antibiotic Susceptibility Patterns and Biofilm Detection of Isolates in Orthopaedic Implant Infections, Journal of Advances in Medicine and Medical Research 2018;25(5):1-12. Article no.JAMMR.38988.
36. Rasouli MR, Tripathi MS, Kenyon R, Wetters N, Parvizi J. Low rate of infection control in enterococcal periprosthetic joint infections. Clin Orthop Relat 2012;470(10):2708-2716. doi:10.1007/s11999-012-2374-8.
37. Holmberg A, Mörgelin M, Rasmussen M.. J AntimicrobialC hemotherapy 2012;67(2):433-439. doi:10.1093/jac/dkr477.
38. Tornero E, Senneville E, Euba G, Petersdorf S, Rodriguez Pardo D, Lakatos B *et al*. Characteristics of prosthetic joint infections due to Enterococcus sp. and predictors of failure: a multi-national study, Clinical Microbiology and Infection 2014;20(11):1219-1224.