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Surgical site infections in a tertiary care center in Rajasthan

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ABSTRACT

Surgical site infections are the 3rd most common nosocomial infections in a hospital setting. It is a menace to both patients and surgeons, as it accounts to 1-3% of all surgical procedures, decreasing the success rate of surgeries. The study was conducted on 90 consecutive patients of Surgical site infection occurring after various surgical procedures within the same surgical team in National Institute of Medical Sciences and Research, Jaipur, from 1st January 2018 till 30th June 2019. The objectives of this study were to assess the etiological factors of surgical site infection, the relationship of these factors with the type of surgical site infection and to isolate the bacteria and the choice of antibiotic therapy suited for such patients. The rate of surgical site infections in our study was 6.99%. This value is relatively low when considering that the majority of the patients that were taken for surgery were in an emergency condition. A relationship was seen between co-morbidities in the form of diabetes mellitus, immunosuppressed patients and patients who smoke, as all of them made up the majority of the patients who developed surgical site infection. As per treatment modalities, patients who had drains placed intra-operatively made up a larger majority of the total patients who had developed surgical site infections compared to those patients who did not have a drain placed. The most common bacteria isolated was Staphylococcus aureus which showed a high sensitivity to piperacilin, vancomycin, linezolid and amikacin.

Keywords— *Surgical Site Infection, Etiology, Antibiotic Sensitivity, Aerobic Bacteria, Infections*

1. INTRODUCTION

Surgical site infections are the 3rd most common nosocomial infections in a hospital setting[1]. By definition, it is an infection that occurs at or near a surgical incision within 30 days of the procedure or within one year if an implant is left in place[2]. It is a menace to both patients and surgeons, as it accounts to 1-3% of all surgical procedures, decreasing the success rate of surgeries[3]. The rate of SSI in abdominal surgeries vary from 15-25% depending upon many factors.[4,5] Risk factors for surgical site infections vary from surgeon to surgeon, institute to institute, one operation theatre to the other, from one procedure to another procedure and most importantly from one patient to another. However, the most important risk factor that is seen to have a significant impact on the formation of surgical site infections is the wound itself. Wounds, as per National Healthcare Safety Network criteria for classifying wounds as clean, clean contaminated, contaminated and dirty. [6] It has been a common practice to prepare the patient for surgery well before the time for which the patient is to be operated. This preparation not only deals with the patient being nil by mouth for over 8 hours before surgery, but the operative site is to also be prepared. This is done in the form of removal of hair, ensuring there is no dirt or possible sources of contamination on the site of surgery. However, there have been many studies suggesting that different methods of patient preparation can significantly reduce the chances of SSI in surgical patients. Once a surgical site infection develops however, it is important to take proper actions to control and eliminate the infection as soon as possible. This can be done by taking a culture of the wound, and starting the patient on prophylactic broad-spectrum antibiotics.

2. AIMS AND OBJECTIVES

The objectives of this study were to assess the etiological factors of surgical site infection, the relationship of these factors with the type of surgical site infection and to isolate the bacteria and the choice of antibiotic therapy suited for such patients.

The present study was conducted with following objectives:

- Analysis of value of preoperative operative site preparation by the surgeon and its relationship with the occurrence of surgical site infection
- Relationship of endogenous host infections and surgery site infections
- Relationship of type of surgery inflicting wounds and outcome of surgical site infection
- Analysis of data of different bacterial strains and their sensitivity

3. MATERIALS AND METHODS

This cross-sectional prospective study was conducted on 90 consecutive patients of Surgical site infection occurring after various surgical procedures within the same surgical team in National Institute of Medical Sciences and Research, Jaipur, from 1st January 2018 till 30th June 2019. Particulars of the patient were noted as well as a detailed history including any chronic illness and habits. No pre-operative antibiotics were given in our cases, to assess true etiological factors of infection and avoiding any resistance development of surgical site infection.

All patients were assessed as per the wound scale given from grade I-IV. After noting the type of surgery, amount of drains inserted, the patients were kept under surveillance of the operative doctor. After 48 hours, when the dressing was first opened, the wound was checked for any signs of inflammation. If present, signs of any discharge were checked by removing the suture at site involved. If pus discharge was present, a sample was sent for culture and sensitivity. When there was no inflammation the above procedure was repeated after 96 hours and 120 hours from the operation time respectively.

3.1 Exclusion Criteria

- All wounds which did not show signs of inflammation within 48, 96 and 120 hours
- All surgical wounds showing signs of inflammation after 120 hours
- All wounds that showed signs of inflammation within 48, 96 and 120 hours with negative bacterial culture.

The methods and materials were approved by the ethical committee.

4. OBSERVATIONS AND RESULTS

Out of the total 90 patients, all patients had undergone open surgery. It is seen in our study that the highest infections were present in patients under the age of 25, followed by patients between the ages of 25-34. The average age however, was 42 years with ± 19 years. There were 62 males and 28 females, as a percentage 31% were female and 69% were male. 21% of the total population in the study had hypertension and 32% were diabetic. Out of all patients that developed surgical site infections, a staggering 57.78% were smokers, suggesting a higher rate of surgical site infections in smokers. Out of the 90 patients that had undergone surgery and developed surgical site infection, 73.33% were emergency cases and only 26.67% had undergone elective cases, hinting at a higher rate of surgical site infection in patients who undergo emergency surgeries.

Table 1: Types of wounds in patients developing surgical site infection

Types of wounds	Number of patients
Clean	1
Clean Contaminated	39
Contaminated	43
Dirty	7

Each patient undergoing surgery was assessed for the nature of their wound. There are 4 types of wound a patient can have, clean, clean contaminated, contaminated and dirty. The most common type of wound was contaminated at 47.78% (n=43) followed by clean contaminated wound at 43.33% (n = 39). Dirty wounds were present in 7.78% (n=7) of patients and clean wounds which developed surgical site infections was only 1.11% (n =1) of patients.

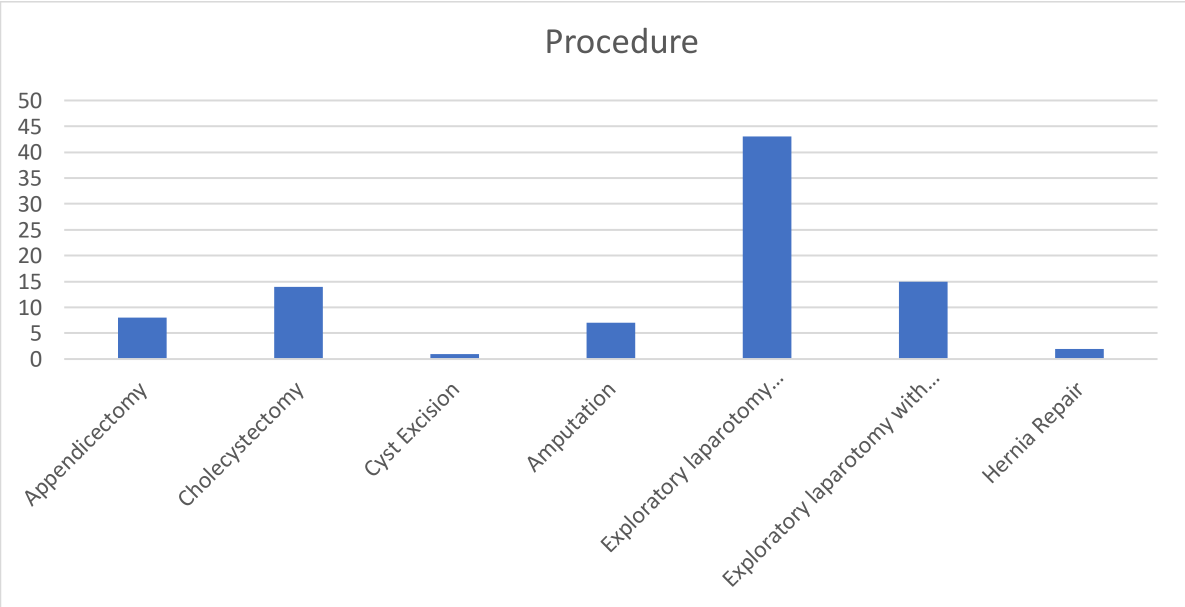

Fig. 1: Procedures done on patients who developed surgical site infections

64.44% (n = 58) of patients who developed surgical site infection had undergone exploratory laparotomy. Out of which 74.14% (43 out of 58, n = 43, total 47.78%) had undergone exploratory laparotomy without resection and anastomosis, and 25.86% (15 out of 58, n = 15, total 16.67%) had undergone exploratory laparotomy with resection and anastomosis. 15.56% (n=14) of patients had undergone cholecystectomy, 8.89% (n=8) patients underwent appendicectomy, 7.78% (n = 7) underwent amputation. The least common procedures where surgical site infections were seen were Hernia repair at 2.22% (n =2) and cyst removal 1.11% (n=1).

Table 2: Number of drains placed in patients who developed surgical site infections

Drains	Number of patients
Nil	25
One	7
Two	58

Drains have an overall impact in the rates of surgical site infection as seen in many studies. Our studies showed that in 90 patients that developed surgical site infections 27.78% (n=25) did not have a drain placed in their surgeries. 7.78% (n=7) patients had a single drain placed whereas the majority of patients, 64.44% (n=58) had 2 drains placed whom later developed surgical site infections.

Table 3: Bacteria isolated from pus culture of surgical site infection wounds

Bacteria	Number of patients
E. Coli	18
Staph Aureus	37
Klebsiella	18
Proteus	2
Pseudomonas	12
Acinetobacter	3

The most common bacteria isolated was Staphylococcus aureus which was present in 41.11% (n=37). This was followed by Klebsiella and Escherichia coli which was present in 20% (n =18) of patients each. Pseudomonas was present in 13.33% (n=12) patients. The least common bacteria isolated were Acinetobacter which was present in 3.33% (n=3) of patients and Proteus which was present in 2.22% (n=2) of patients.

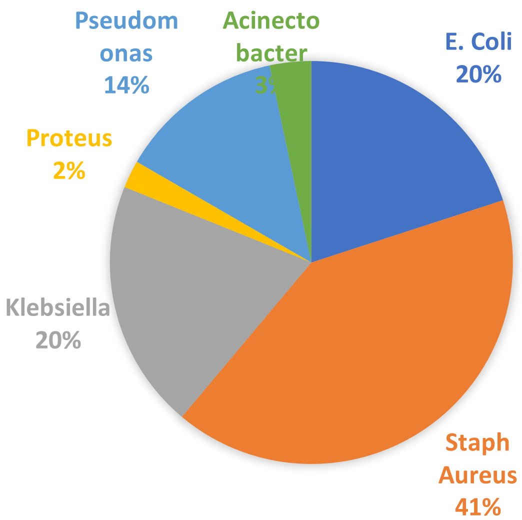

Fig. 2: Pie chart depicting percentage of bacteria isolated

Of the bacteria isolated from patients developing surgical site infections, *Staphylococcus aureus* was most common. Drugs that were sensitive to this bacterium were as follows: Piperacillin 100%, Vancomycin 96.97%, Linezolid 96.43%, Amikacin 92.31%, Cefoxitin 81.48%, Ceftriaxone 72.73%, Tetracycline 72.73%, Gentamycin 69.23%, Erythromycin 56.25%, Imipenem 50%, Meropenem 50%, Levofloxacin 50% and Ampicillin 27.59%.

Klebsiella had drug sensitivity follows: Ampicillin 0%, Amikacin 55.56%, Piperacillin 75%, Imipenem 64.29%, Meropenem 100%, Tetracycline 50%, Erythromycin 0%, Gentamycin 90.91%, Cefoxitin 0%, Ceftriaxone 37.5%, Levofloxacin 41.67% and Linezolid 100%.

Escherichia coli had drugs that were sensitive to this bacterium as follows: Ampicillin 66.67%, Amikacin 91.67%, Piperacillin 72.73%, Imipenem 100%, Meropenem 100%, Tetracycline 77.78%, Erythromycin 33.33%, Gentamycin 80%, Cefoxitin 100%, Ceftriaxone 23.08%, Levofloxacin 53.33%, Vancomycin 50% and Linezolid 100%.

Pseudomonas had drugs sensitive to this bacterium as follows: Ampicillin 0%, Amikacin 66.67%, Piperacillin 100%, Imipenem 90%, Meropenem 100%, Tetracycline 60 %, Gentamycin 58.33%, Cefoxitin 0%, Ceftriaxone 0%, Levofloxacin 87.5%.

Acinetobacter Drugs that were sensitive to this bacterium were as follows: Piperacillin 0%, Imipenem 100%, Meropenem 100%, Tetracycline 33.33%, Gentamycin 0%, Levofloxacin 33.33%, Vancomycin 50% and Linezolid 100%.

Proteus had very high sensitivity to drugs which were tested for sensitivity. Tetracycline was the only drug tested which was resistant. Drugs that were sensitive to this bacterium were as follows: Ampicillin 100%, Amikacin 100%, Meropenem 100%, Tetracycline 0%, Gentamycin 100%, Cefoxitin 100%, Ceftriaxone 100%, Levofloxacin 100%.

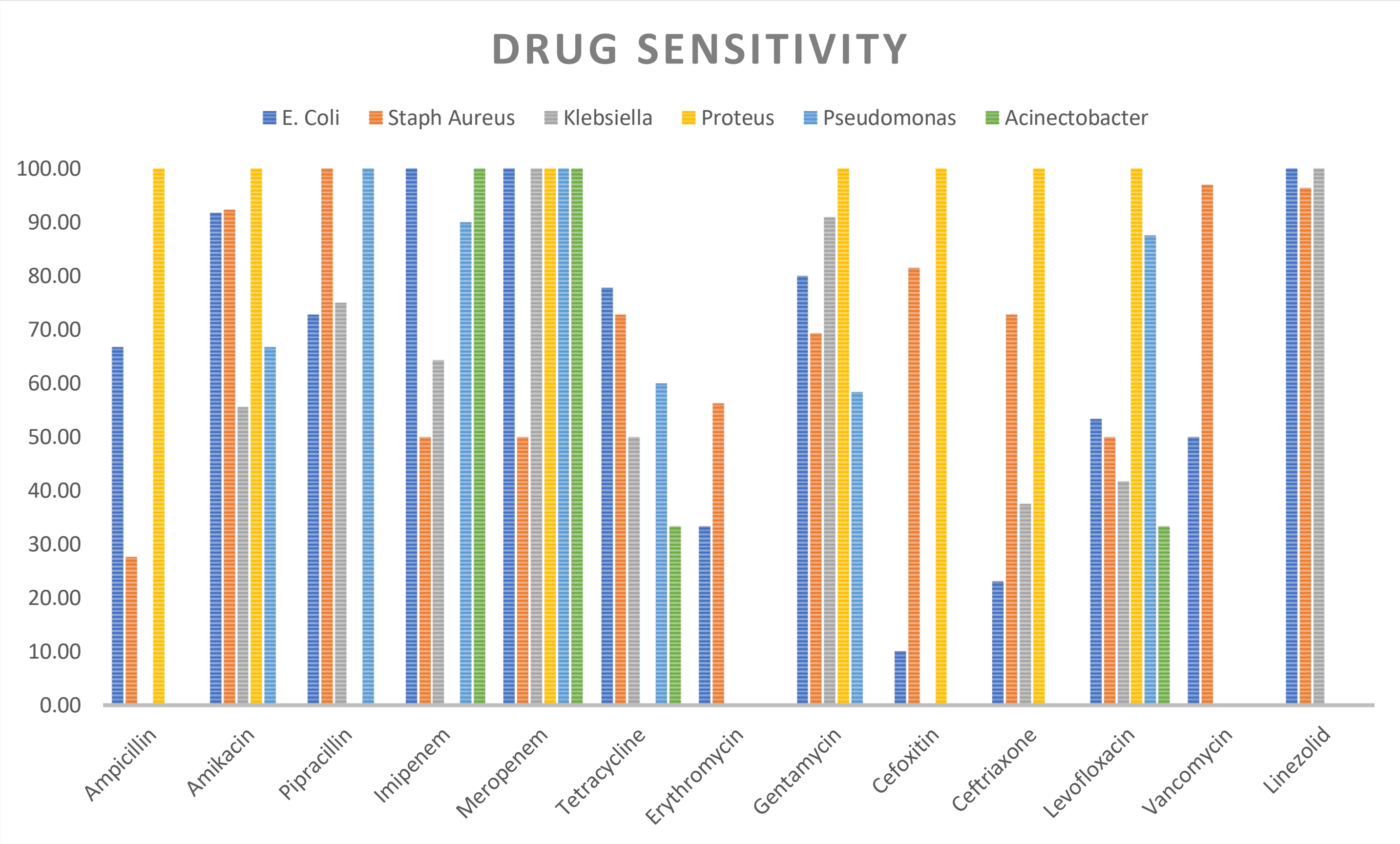

Fig. 3: Drug Sensitivity to isolated bacteria

5. DISCUSSION

A total of 90 patients were enrolled in this study. These patients were selected from a total of 1286 patients out of which 10.49% (n= 135) developed signs of inflammation with pus within 120 hours of surgery. Out of 135, only 90 were culture positive and hence were included in the study, as per the inclusion and exclusion criteria. Once 90 patients were fulfilled, no other patients were observed. This shows that our institute has a surgical site infection rate of 6.99%.

In a similar Indian setting of Dr. DY Patil Medical College, Hospital and Research Centre, Pune, the level of surgical site infection quoted by **Shahane et al**. was 6%. [7] Fan et al. [8] showed a value of 4.5% in Mainland China and **Pathak et al**. [9] showed a rate of 5%. This is very similar to our study which is only slightly higher.

Another study by **Etok et al.** [10] showed a rate of infection at 8.8%, which is slightly higher than our value of 6.99%. Also slightly high was the values published by **Alkaaki et al** at 16.3%. [11] Drains have an overall impact in the rates of surgical site infection as seen in many studies. Our studies showed that in 90 patients that developed surgical site infections 27.78% (n=25) did not have a drain placed in their surgeries. 7.78% (n=7) patients had a single drain placed whereas the majority of patients, 64.44% (n=58) had 2 drains placed whom later developed surgical site infections. **Mawalla et al.** showed that out of all the patients that developed surgical site infections had drains placed in 40% of all patients. **Shahane et al.** had a total of 13.6% patients who had drains placed whom later developed surgical site infections. **Pathak et al.** registered that 19% of all patients who underwent surgery had drains placed out of which 50% developed a surgical site infection. **Lindsjö et al.** showed that 103 patients had developed surgical site infections for which 33% had drains placed. **Alkaaki et al.** in their study showed that of all patients who had surgical site infection, 49% of patients had a drain inserted. All studies show that approximately half of the patients who had surgical site infection had a drain placed. Our study shows a slightly higher percentage than the general consensus.

Majority of our patients developing surgical site infections were patients who underwent emergency surgeries, 73.33% (n = 66). 26.67% of patients developing surgical site infection underwent planned/elective surgeries. This is in agreeance to **Khairy et al.** whose study showed that 66.67% of their surgical site infection patients were surgeries done in emergency settings and 33.33% were elective surgeries. **Alkaaki et al.** also had more emergency surgeries who developed surgical site infections at 54% compared to 45% cases were elective.

Mawalla et al. had more elective cases than emergency, 83% as compared to 17%. This was also seen in **Shahane et al.** study where they had 63% elective in comparison to 37% emergency cases. **Pathak et al.** showed similar results with 8.33% of their cases being emergency surgeries and 91.67% cases being elective. **Lindsjö et al.** also had more elective cases than emergency at 90.2% cases being elective and 9.8% being emergency. **Laloto et al.** also had approximate 1/3rd of cases as emergency 2/3rd as elective.

Each patient undergoing surgery was assessed for the nature of their wound. There are 4 types of wound a patient can have, clean, clean contaminated, contaminated and dirty. The most common type of wound was contaminated at 47.78% (n=43) followed by clean contaminated wound at 43.33% (n = 39). Dirty wounds were present in 7.78% (n=7) of patients and clean wounds which developed surgical site infections was only 1.11% (n =1) of patients.

Khairy et al. had no dirty wounds in their patient data. Out of their surgical site infections 44.44% were clean contaminated, 33.33% were contaminated and 22.22% were clean cases. Likewise, **Shahane et al.** shows that they had most surgical site infections in contaminated wounds at 12.3% of their total surgeries followed by clean contaminated at 8% of all surgeries and 4.6% of all surgeries developing surgery site infection in clean wounds. **Alkaaki et al.** showcased that the majority of their patients developing surgical site infections had a clean-contaminated wound 69% followed by dirty/clean-contaminated patients, 25% and last of all by clean cases 5%.

Mawalla et al. did not have any dirty cases in their study, however their results were trending in the opposite direction with most surgical site infection occurring in clean cases and least in contaminated cases. 63% of their surgical site infections happened in clean cases, 30.7% in clean contaminated cases and 6.3% in contaminated cases. Similar was seen in the study by **Pathak et al.** where clean and clean contaminated cases made up 61.32% of total number of patients that developed surgical site infections and only 39.68% made up the rest of the surgical site infection patients with patients who had contaminated or dirty wounds. **Lindsjö et al.** had no patients who developed a surgical site infection from a dirty or contaminated wound and all of their 103 patients who had surgical site infections resulted from clean or clean-contaminated wounds. This is not unexpected as out of the 1478 surgeries conducted in their institute, only 9 (0.6%) had dirty or contaminated wounds. **Laloto et al.** also had no dirty or contaminated cases. 41.9% of their surgical site infection patients had a clean wound whereas 58.1% had clean-contaminated wounds.

The most common bacteria isolated was *Staphylococcus* aureus which was present in 41.11% (n=37). This was followed by *Klebsiella* and *Escherichia* coli which was present in 20% (n =18) of patients each. *Pseudomonas* was present in 13.33% (n=12) patients. The least common bacteria isolated were *Acinetobacter* which was present in 3.33% (n=3) of patients and *Proteus* which was present in 2.22% (n=2) of patients. **Khairy et al.** showed that the most common bacteria isolated from their pus cultures was *Escherichia* coli 34.78% followed by *Pseudomonas* 26.1% and *Staphylococcus* aureus 17.4%. **Mawalla et al.** showed in their cultures Staphylococcus aureus 16 (28.6%), was the most common isolated bacteria. This was followed by Escherichia coli 14 (25.0%) and Klebsiella pneumoniae 10 (17.9%). The least isolated bacteria were Acinetobacter spp 1(1.8%). These findings are similar to the findings from our patients. Also like our study, **Pathak et al.** showed that the most common bacteria isolated from their study was *Staphylococcus* aureus at 63.64% followed by *Pseudomonas* at 27.28% and lastly *Escherichia* coli at 9.1%. Likewise, the most common bacteria isolated by **Bastola et al.** was also S. aureus (21.8%). This was followed by E. coli (21.8%), P. aeruginosa (15.4%), K. pneumonaie (13.6%) and Acinetobacter anitratus (10.9%). Proteus also made up their least isolated bacteria at 0.9%.

A slightly different outcome was obtained by **Shahane et al.** with the most common isolated bacteria being Escherichia coli at 31.25% followed by Pseudomonas aeruginosa 25% and then Staphylococcus aureus at 22%. This result was similar to that of **Alkaaki et al.** whose most common bacteria was *Escherichia* coli followed by *Staphylococcus* aureus.

Etok et al had a completely different percentage of isolated bacteria. The isolates were Proteus spp (33.3%), followed by E. coli (20.0%), Staphylococcus aureus (20.0%) coagulase negative staphylococcus 20 (13.3%), Klebsiella spp 10 (6.7%) and Pseudomonas spp 10 (6.7%). Our study showed proteus to be the least identified organism and Klebsiella being the second most common. This could be due to the fact that this study was conducted in Nigeria and the strains of bacteria are significantly different to those present in India.

Of the bacteria isolated from patients developing surgical site infections, *Staphylococcus* aureus was most common. Drugs that were sensitive to this bacterium were as follows: Ampicillin 27.59%, Amikacin 92.31%, Piperacillin 100%, Imipenem 50%, Meropenem 50%, Tetracycline 72.73%, Erythromycin 56.25%, Gentamycin 69.23%, Cefoxitin 81.48%, Ceftriaxone 72.73%, Levofloxacin 50%, Vancomycin 96.97% and Linezolid 96.43%.

Klebsiella had drug sensitivity follows: Ampicillin 0%, Amikacin 55.56%, Piperacillin 75%, Imipenem 64.29%, Meropenem 100%, Tetracycline 50%, Erythromycin 0%, Gentamycin 90.91%, Cefoxitin 0%, Ceftriaxone 37.5%, Levofloxacin 41.67% and Linezolid 100%.

Escherichia coli Drugs that were sensitive to this bacterium were as follows: Ampicillin 66.67%, Amikacin 91.67%, Piperacillin 72.73%, Imipenem 100%, Meropenem 100%, Tetracycline 77.78%, Erythromycin 33.33%, Gentamycin 80%, Cefoxitin 100%, Ceftriaxone 23.08%, Levofloxacin 53.33%, Vancomycin 50% and Linezolid 100%.

Pseudomonas Drugs that were sensitive to this bacterium were as follows: Ampicillin 0%, Amikacin 66.67%, Piperacillin 100%, Imipenem 90%, Meropenem 100%, Tetracycline 60 %, Gentamycin 58.33%, Cefoxitin 0%, Ceftriaxone 0%, Levofloxacin 87.5%. *Acinetobacter* Drugs that were sensitive to this bacterium were as follows: Piperacillin 0%, Imipenem 100%, Meropenem 100%, Tetracycline 33.33%, Gentamycin 0%, Levofloxacin 33.33%, Vancomycin 50% and Linezolid 100%.

Proteus had very high sensitivity to drugs which were tested for sensitivity. Tetracycline was the only drug tested which was resistant. Drugs that were sensitive to this bacterium were as follows: Ampicillin 100%, Amikacin 100%, Meropenem 100%, Tetracycline 0%, Gentamycin 100%, Cefoxitin 100%, Ceftriaxone 100%, Levofloxacin 100%.

Mawalla et al. emphasised that in their study, the majority of gram-negative isolates were sensitive to meropenem while gram positive being sensitive to vancomycin and clindamycin. **Shahane et al.** revealed enterobacteriaceae showing highest sensitivity to amikacin (78%) followed by gentamicin (71%). In comparison, very low sensitivity is noted with the cephalosporins and fluoroquinolones (10% and 58% respectively). Pseudomonas isolates showed good sensitivity to piperacilin-tazobactam, ceftazidime and imipenem (83.5%, 83% and 100% respectively). Staphylococcus aureus showed maximum sensitivity to linezolid (87.3%), gentamicin (100%), clindamycin (100%) vancomycin (100%). **Etok et al.** conveyed through their study that amongst the gram negatives, E. coli and Proteus spp showed sensitivity to Amoxycillin clavulanate and Ceftazidime while Klebsiella spp was completely resistant to Amoxycillin-clavulanate, Cefpodoxime, Cefotaxime, Levofloxacin Trimethoprim-sulfamethaxole and Ceftazidime. The organism was 100% sensitive to Imipenem.

Bastola et al. showed in their study, all isolates of S. aureus were sensitive to Amikacin, Ceftriaxone, Meropenem, Ampicillin-sulbactam, Cefoperazonesulbactam and Vancomycin. Among Gram negative bacterial isolates, the most effective drug was Amikacin (81.9%) followed by Cefoperazone-sulbactam (74.7%) and the least effective drug were Ceftriaxone (31.3%) and Ceftazidime (36.1%).

6. CONCLUSION

The rate of surgical site infections in our study was 6.99%. This value is relatively low when considering that the majority of the patients that were taken for surgery were in an emergency condition. Majority of the patients had contaminated or clean contaminated wounds. This was a major factor contributing to development of surgical site infection in our patients. A relationship was seen between co-morbidities in the form of diabetes mellitus, immunosuppressed patients and patients who smoke, as all of them made up the majority of the patients who developed surgical site infection. As per treatment modalities, patients who had drains placed intra-operatively made up a larger majority of the total patients who had developed surgical site infections compared to those patients who did not have a drain placed. The most common bacteria isolated was Staphylococcus aureus which showed a high sensitivity to piperacilin, vancomycin, linezolid and amikacin.

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