**INTRODUCTION**

The wound infections consider to be one of the most common nosocomial infections and are a significant cause of morbidity and account for 70-80% mortality. Wound infections were caused by several pathogenic microorganisms that are bacteria, fungi, and parasites as well as virus. Enterococci, *Escherichia*, *Pseudomonas*, *Klebsiella*, *Enterobacter*, *Proteus* and *Acinetobacter* were recorded the most common infecting wounds. Advances in infections control of wound have become more challenging resulting from prevalent of microorganism’s resistance to antibiotics, and to a more occurrence of infections caused by methicillin- resistance *S. aureus* and polymicrobial flora. The problem of antimicrobial resistance is challenging in low-income countries resulting from high occurrence of infections, misuses of antimicrobials, over the counter availability of drugs and lack of diagnostic laboratories for susceptibility testing of antibiotics. Also, the antibacterial resistance can increase problems and expenses associated with digenesis and treatment. However, very limited information is available on the type of isolated bacteria and their antibacterial resistance associated with infected wound in Aden Hospitals, Yemen. So, the present investigation was...
carried out to isolate and identify the pathogenic bacteria from surgical wound infections and determine their sensitivity to common antibiotics.

MATERIALS AND METHODS

Samples Collection
One hundred and twenty (120) samples were collected from wound patients that undergo a surgical operation in three general hospitals, Algomhori, Khalifa, and Alsadaka, in Aden City of Yemen. By using a sterile cotton swab, the wound samples were swabbed gently from the superficial, medium or deep of the infected area and the samples were immediately transported to the laboratory. Each sample was inoculated on McConkey agar, Nutrient agar and Blood agar (Himedia, India) and then incubated for 24 hrs 37°C.

Identification of isolated bacteria
Isolated bacteria were subjected to standard microbiological identification tests based on morphological characteristics for colony, microscopically, and biochemical tests to confirm their identity/purity.

Antibacterial susceptibility testing
The antibacterial sensitivity testing was performed by using disk diffusion methods on Mueller–Hinton agar based on Kirby–Bauer method. Ten types of antimicrobial agents tested were: amoxicillin (30 μg), cefazidime (30 μg), ciprofloxacin (5 μg), vancomycin (30 μg), ceftriaxone (30 μg), nitrofurantoin (30 μg), tetracycline (30 μg), erythromycin (15 μg), nalidixic acid, (30 μg), gentamicin (10 μg) (Himedia, India). The plates were incubated for 18-24 hrs at 37°C. The obtained inhibition zones were determined in millimeters.

RESULTS
In the current results, 120 samples were collected from both sexes (males and females) with surgical wound infection. 88 samples (73.33%) from males and 32 samples (26.67%) from females as shown in Figure 1.

Table 1: Resistance and sensitivity pattern of isolated S. aureus

| Antibiotics       | Resistant (%) | Sensitive (%) | Total |
|-------------------|---------------|---------------|-------|
| Amoxicillin       | 14 (51.9)     | 13 (48.1)     | 27    |
| Cefotaxine        | 0 (27(100))   | 27(100)       | 27    |
| Cefazidime        | 27 (100)      | 0 (27)        | 27    |
| Ciprofloxacin     | 4 (14.9)      | 23 (85.1)     | 27    |
| Erythromycin      | 20 (74.1)     | 7 (25.9)      | 27    |
| Gentamycin        | 10 (37)       | 17 (63)       | 27    |
| Nalidixic acid    | 24 (88.9)     | 3 (11.1)      | 27    |
| Nitrofurantoin    | 12 (48.1)     | 15 (51.9)     | 27    |
| Tetracycline      | 23 (85.19)    | 4 (14.81)     | 27    |
| Vancomycin        | 1 (3.7)       | 26 (96.3)     | 27    |

The medium-resistant of S. aureus was recorded to amoxicillin at 51.9% and nitrofurantoin at 48.1%. S. aureus showed very high sensitivity to cefotaxime (100%) followed by vancomycin (96.3%) and ciprofloxacin (85.1%) as shown in Table 1.

Figure 2: The percentage of bacterial growth in media
The isolated E. coli from wounds indicated 100% resistant to vancomycin and tetracycline. Also, E. coli showed high resistance nalidixic acid (73.7%), erythromycin and amoxicillin (68.4%), nitrofurantoin and cefotaxime (63.2%). It was moderately resistant to gentamycin at 36.8% as listed in Table 2.

Table 2: Resistance and sensitivity pattern of isolated E. coli

| Antibiotics       | Resistant (%) | Sensitive (%) | Total |
|-------------------|---------------|---------------|-------|
| Amoxicillin       | 13 (68.4)     | 6 (31.6)      | 19    |
| Cefotaxine        | 12 (63.2)     | 7 (36.8)      | 19    |
| Cefazidime        | 10 (52.6)     | 9 (47.4)      | 19    |
| Ciprofloxacin     | 7 (36.9)      | 12 (63.1)     | 19    |
| Erythromycin      | 13 (68.4)     | 6 (31.6)      | 19    |
| Gentamycin        | 7 (36.8)      | 12 (63.2)     | 19    |
| Nalidixic acid    | 14 (73.7)     | 5 (26.3)      | 19    |
| Nitrofurantoin    | 12 (63.2)     | 7 (36.8)      | 19    |
| Tetracycline      | 19 (100)      | 0 (0)         | 19    |
| Vancomycin        | 19 (100)      | 0 (0)         | 19    |

The P. mirabilis isolates showed sensitive to cefazidime at 88.9% followed by cefotaxime ciprofloxacin, and gentamycin at 77.8% for each. Most of the P. mirabilis were highly resistant to amoxicillin, erythromycin, and vancomycin at 100% and followed by nitrofurantoin at 88.9% as listed in Table 4.

Figure 3: The type of isolated bacteria and their frequency
P. aeruginosa showed high resistance to amoxicillin and vancomycin at 100%, followed by tetracycline at 92.3%, erythromycin at 84.6%, nalidixic acid and nitrofurantoin at 76.9%, ciprofloxacin at 69.2%. P. aeruginosa was sensitive to gentamycin (76.9) and ceftazidime (69.2) as shown in Table 3.

DISCUSSION

The infection of wounds by different bacteria resulting from nosocomial infection and treatment of wound infections remains an important concern for surgeons. The type and cell number of bacteria play an important role in developing of wound infection. In the present study, it was revealed that the 88 samples (73.33%) were collected from males and 32 samples (26.67%) from females. This result is similar to the findings by Anthony et al. who recorded that the up of 40 samples were collected from males and 24 from females. Of 120 samples processed, 68 samples (56.67%) were recorded as positive growth and 52 samples (43.33%) were observed as negative growth. In a study by Farrag et al. revealed that the 41 samples (82%) collected from wound infections were reported as positive growth for bacteria and only 9 samples were showed no growth for bacteria.

Table 3: Resistance and sensitivity pattern of isolated P. aeruginosa

| Antibiotics     | Resistant (%) | Sensitive (%) | Total |
|-----------------|---------------|---------------|-------|
| Amoxicillin     | 13(100)       | 0             | 13    |
| Cefotaxime      | 4(30.8)       | 9(69.2)       | 13    |
| Ceftazidime     | 6(46.2)       | 7(53.8)       | 13    |
| Ciprofloxacin   | 9(69.2)       | 4(30.8)       | 13    |
| Erythromycin    | 11(84.6)      | 2(15.4)       | 13    |
| Gentamycin      | 3(23.1)       | 10(76.9)      | 13    |
| Nalidixic acid  | 10(76.9)      | 3(23.1)       | 13    |
| Nitrofurantoin  | 10(76.9)      | 3(23.1)       | 13    |
| Tetracycline    | 12(92.3)      | 1(7.7)        | 13    |
| Vancomycin      | 13(100)       | 0             | 13    |

In the present, four of pathogenetic bacteria which isolated from 68 morbidity condition cause infections wounds surgeries were identified. These pathogenic bacteria are S. aureus, E. coli, P. aeruginosa, and P. mirabilis. The results showed that S. aureus was the predominant (39.70%) followed by E. coli (27.94%), P. aeruginosa (19.12%), and P. mirabilis (13.24%). In a similar investigation by Tayfour et al. observed that the S. aureus was the most bacteria isolated from King Fahd Hospital patients with 33.5% percentage. A study by Anthony et al. revealed that the S. aureus was the predominant bacteria (25%), followed by P. aeruginosa (20%), E. coli (15%), and P. mirabilis (10%). S. aureus exists naturally on the skin surface by 40-60% of healthy people as well as present in the hospital environment. It is the main cause of infection in public hospitals, and the role of convalescence and hospitals that provide health care for acute cases. Poor wound management allows the bacteria to invade the inner tissue and bring about chronic systemic infection. The P. aeruginosa bacteria are common in hospitals and the presence of diseases associated with hospital-acquired infections that are transmitted saluting this type of bacteria, mainly from non-living sources to the body's tissues by disinfectants and surgical instruments used. The E. coli bacteria that normally live in the human's colon and often cause infections of wounds contaminated with urine. Most of the contaminated wounds with hospital-acquired infections such as bacteria are known due to poor hospital hygiene.

Table 4: Resistance and sensitivity pattern of isolated P. mirabilis

| Antibiotics     | Resistant (%) | Sensitive (%) | Total |
|-----------------|---------------|---------------|-------|
| Amoxicillin     | 9(100)        | 0             | 9     |
| Cefotaxime      | 2(22.2)       | 7(77.8)       | 9     |
| Ceftazidime     | 1(11.1)       | 8(88.9)       | 9     |
| Ciprofloxacin   | 2(22.2)       | 7(77.8)       | 9     |
| Erythromycin    | 9(100)        | 0             | 9     |
| Gentamycin      | 2(22.2)       | 7(77.8)       | 9     |
| Nalidixic acid  | 6(66.7)       | 3(33.3)       | 9     |
| Nitrofurantoin  | 8(88.9)       | 1(11.1)       | 9     |
| Tetracycline    | 4(44.4)       | 5(55.6)       | 9     |
| Vancomycin      | 9(100)        | 0             | 9     |

The P. mirabilis bacteria was found in hospitals and it has an active role in bringing about infections of wounds and burns. Most of the bacteria that exhibited higher rates of antibacterial resistance are human normal flora and biofilm-forming pathogens such as S. aureus, P. aeruginosa, and E. coli. In this study, the S. aureus showed high resistance against many antibiotics that used to treat the S. aureus infection such as erythromycin and tetracycline. In contrast, S. aureus showed very high sensitivity to cefotaxime, vancomycin, and ciprofloxacin. These findings are in consistent with the study of Adcock and Sani et al. who recorded that pathogenic Staphylococci are resistant to several antibiotics. Resistance of this bacterium to erythromycin group tends to develop so rapidly. Therefore, it should not be used these group of antibiotics singly for the treatment of chronic infection.

The resistance of tetracycline and erythromycin antibiotics were determined by plasmids that can be transmitted between Staphylococci species by transduction and maybe by conjugation. The E. coli isolated from wounds indicated 100% resistant to vancomycin and tetracycline. Also, E. coli exhibited high resistance to nalidixic acid (73.7%), erythromycin and amoxicillin (68.4%), nitrofurantoin and cefotaxime (63.2%). This finding is in agreement with the work of Adwan et al. who documented that the E. coli recorded resistance to many of antibiotics used to treat its infection. Also, in this study, E. coli was moderately resistant to gentamycin inhibitory (36.8%). Similar results were reported by Giacometti et al. found that the E. coli was resistant to gentamycin at 50% and ciprofloxacin at 36.7%. Giacometti et al. reported that E. coli was resistant to gentamycin at 50% and ciprofloxacin at 36.7%. In the present study P. aeruginosa was observed to reduce sensitivity to most used antibiotics especially for ciprofloxacin (69%), ceftazidime (83.3%) and ciprofloxacin (69.2%) that have been specified to be the most effective oral antibiotic existing for the treatment of infections caused by P. aeruginosa. The reducing resistance of P. aeruginosa to ciprofloxacin was documented in India by Raja and Singh. On the other hand, P. aeruginosa showed resistance to gentamicin (87.5%) and to...
tetracycline (57%) . P. aeruginosa able to causes completely infection in parts of the human body. The Pseudomonas species are naturally resistant to a wide variety of antibiotics due to mechanisms such as efflux pumps and the ability to form biofilm that decreases further P. aeruginosa sensitivity to antibiotics . The existence of such biofilm greatly contributes to persistent bacterial infections in surgical sites resulting from their ability to tolerant to all antimicrobial agents and immune cells . The P. mirabilis isolates revealed sensitive to ceftazidime at 88.9% and cefotaxime ciprofloxacin and gentamycin at 77.8% for each. Most of the P. mirabilis were highly resistant to amoxicillin, erythromycin, and vancomycin at 100% and followed by nitrofurantoin at 88.9%. These results agree with the results reported by Mordi and Momoh and Manikandan and Amsath.

CONCLUSION

In conclusion, the increase of isolated bacteria resistance to used antibiotics due to unrestrained, mismanagement, extensive incorrect, and misuse of antimicrobial agents in hospitals and whole of country. Also, this is promoted by the absence of polices for National antibiotics and over-the-counter antibiotic obtain ability in Yemen. Hence, it is essential to establish the national antibiotic policies that regulate the operation for giving the patients antibiotics before performance the antibiotics sensitivity test to know the effective antibiotic.

CONFLICT OF INTEREST

No conflict of interest associated with this work.

AUTHOR'S CONTRIBUTION

All authors have worked equally for this work.

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