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# Distribution and Antimicrobial Resistance Pattern of Bacteria Isolated from Operation Theaters at Gaza Strip

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***Abstract**: A five month prospective study was fulfilled to determine the prevalence of bacterial contamination in operation theaters at main hospitals of Gaza Strip, types and frequency of these bacteria and their antibiotic resistance pattern.*

*The bacterial isolates were identified by conventional methods and the antibiotic susceptibility profiles were determined by the standard disc diffusion method according to CLSI guidelines.*

*Out of a total of 243 swabs investigated, 24.7% were contaminated and yielded bacterial genera. There were seven bacterial genera isolated with highest prevalence of Staphylococcus spp. (45.3%), followed by Enterobacter spp. (23.4%), Escherichia coli, Klebsiella spp. and Acinetobacter spp. (7.8% for each). The other genera include Pseudomonas spp. (4.7%) and Streptococcus spp. (3.1%). Most of the recovered isolates of the genus Staphylococcus were coagulase negative staphylococci accounting 89.7% of the total isolated staphylococci.*

*The antibiotic susceptibility profiles of Gram negative isolates revealed that the most effective antibiotics were imipenem and tobramycin with no resistance rate (0.0%), then amikacin with resistance rate of 6.1%, gentamicin 15.2%, and ciprofloxacin 27.3%. However, the highest resistance was against ampicillin and amoxicillin with 93.9% for each, followed by cefazolin 81.8%. On the other hand, Gram positive isolates (all are staphylococci) were also found to be highly resistant against penicillin and ampicillin (93.1%, 86.2 respectively). All isolates were completely sensitive and there was a lack of resistant isolates against vancomycin. However, low resistance pattern was revealed against rifampin, doxycycline (3.4% each) and ciprofloxacin (24.1%).*

*Among Gram negative isolates, there were 9.1% extended spectrum beta-lactamase producers which were from Escherichia coli (40%) and Klebsiella spp. (20%). Methicillin resistance was detected in 62.1% of staphylococci isolates, where methicillin resistance Staphylococcus aureus (MRSA) and*

*methicillin resistance coagulase-negative staphylococci (MR-CoNS) account for 33.3% and 65.4% respectively.*
*In conclusion, this study demonstrated presence of moderate bacterial contamination in operation theaters with increased potential to the commonly used antimicrobial agents.*

***Keywords:*** *Antimicrobial resistance pattern, Bacteria, Operation theaters, ESBL, MRSA.*

## Introduction:

Operation theater considered as a complex environment that possess a high risk of infection for patients and health care workers who may easily contract diseases because of their long exposures to various risks, including chemical, physical and biological factors (Gioffrè, et al., 2007). Contamination of operating theatres is one of the most life-threatening sources of nosocomial infection for patients, especially in transplant surgery, heart surgery, cystoscopy and transurethral resection of prostate and bladder tumors (Dharan & Pittet, 2002; Ensayef, et al., 2009).

It was estimated that over 1.4 million people worldwide are suffering from nosocomial infections, where between 5% and 10% of patients admitted to modern hospitals in the developed world acquire one or more infection. There are many countries suffer from increased rates of post operation infection in their hospitals, especially in developing countries (Mayon, et al., 1988; Pittet & Donaldson, 2006). The risk in developing countries is 2 to 20 times higher (Pittet & Donaldson, 2006) and in some developing countries, the proportion can exceed 25%.

The intraoperative environment is considered as an important reservoir to the development of health care–associated infections (HAIs) (Da Costa et al., 2008; Loftus et al., 2011). The biological contamination in the operating rooms is mostly imputable to airborne and blood borne microorganisms, whose primary source represent the staff, patient and operating team (Gioffrè, et al., 2007). Health care associated infections are an important cause of morbidity and mortality in hospitals. In the United States, surgical site infections (SSIs) considered as the second most common types of nosocomial

infection, where approximately half million SSIs occur annually, accounting for 3.7 million excess hospital days and cost more than 1.6$ billion in extra hospital charges (William, & Ronald, 2001).

Post-operative wound infection delays recovery and often increases length of stay and may produce lasting sequelae and require extra resources for investigations, management and nursing care. Therefore, its prevention or reduction is relevant to quality patient care (Edmiston, et al., 2007; Scaltriti et al., 2007). Based on national nosocomial infections surveillance system (NNIS) reports, SSIs are the third most frequently reported nosocomial infection, accounting for 14% to 16% of all nosocomial infections among hospitalized patients (Alicia, 1999).

The emergence of resistance to antimicrobial agents is a global public health problem particularly in pathogens causing nosocomial infections. Antimicrobial resistance results in increased illness, deaths and health care costs (Cohen, 1992; Savas, et al., 2006). Treatment of these infections is frequently complicated by antibiotic resistance, a problem that has been increasing over time. The emergence of multi-drug resistant strains in hospital environment, particularly in developing countries is an increasing infection control problem and associated with high frequency of HAIs and antibiotic resistance rate (Akhtar, 2010).

The aim of this study was to determine the causative agents of bacterial contamination in general operation theaters in main Gaza strip hospitals and their resistance patterns to commonly used antibiotics in these hospitals.

## Materials and methods

### *Microbiological methods*

*Isolation and identification of bacteria*

A total of 243 swabs were collected, 142 (58.4%) from the public hospitals and 101 (41.6%) from the private hospital's operation theaters. The swabs were inoculated onto blood, MacConkey and Baired-Parker agars using an aseptic streaking technique. The inoculated plates were incubated aerobically at 35-37 °C for 18-24

hours. Bacterial identification was based on standard culture and biochemical characteristics of isolates. Gram negative bacteria were identified by standard biochemical tests. Gram positive bacteria were identified with the corresponding laboratory tests including Gram staining, catalase and coagulase. When no growth was observed on plates after 24 hours, they were re-incubated under the same conditions for further 24 hours before discarded and recorded as negative result. Biochemical identification kits, such as API systems for *Enterobacteriaceae* and staphylococci, were used to identify the bacterial isolates at the species level (http://www.biomerieuxindustry.com).

*Antibiotic susceptibility testing*

Antimicrobial susceptibility testing of isolated bacteria were determined by the disk diffusion method (Kirby-Bauer) according to the Clinical and Laboratory Standards Institute (CLSI) recommendations, using Mueller-Hinton medium (CLSI, 2009). Briefly, single isolated colonies were selected and inoculated in Mueller-Hinton broth until its turbidity is comparable to 0.5 McFarland turbidity standards. Then the plates were inoculated with each broth culture and left to dry at room temperature before the application of antibiotic discs. The plates were incubated at 35-37 °C for 18-24 hours. Zone of inhibition for each antimicrobial agent was interpreted, reporting the organism as resistant, intermediate or susceptible. For Gram negative bacteria, the panel of antibiotics used included: ampicillin, ampicillin-sulbactam, amoxicillin, amoxicillin-clavulanic acid, piperacillin, cefazolin, cefaclor, cefotaxime, ceftriaxone, cefoxitin, ceftazidime, imipenem, gentamycin, tobramycin, amikacin, ciprofloxacin and trimethoprim-sulfamethoxazole. For Gram positive bacteria, the following panel was used: penicillin, ampicillin, oxacillin, vancomycin, erythromycin, clindamycin, gentamycin, cefoxitin, amikacin, doxycycline, ciprofloxacin, rifampin and trimethoprim-sulfamethoxazole.

*Screening for ESBL-producer isolates*

Extended spectrum beta-lactamase producer Gram negative isolates were tested using cefotaxime and ceftriaxone according to the CLSI standard (CLSI, 2009). Reduced susceptibility to cefotaxime (30 µg)

and ceftriaxone (30 µg) with zone sizes ≤ 27 mm and ≤ 25 mm respectively was used as screening method for ESBL production.

*Screening for methicillin resistance among staphylococci isolates*

Methicillin-susceptible *Staphylococcus aureus* strains (MSSA) and methicillin-susceptible coagulase negative staphylococci (MS-CoNS) were differentiated from methicillin-resistant *Staphylococcus aureus* strains (MRSA) and methicillin-resistant coagulase negative staphylococci (MR-CoNS) according to the CLSI guidelines 2009 (CLSI, 2009). Oxacillin disc (1 µg) was used as screening method to test for methicillin resistance. Isolates that showed growths around oxacillin disc were considered methicillin resistance, while those that did not grow were considered as methicillin sensitive.

*Statistical analysis*

Data were tabulated, encoded and statistically analyzed using the Statistical Package for the Social Sciences (SPSS) version 15 software. Discrete variables were expressed as percentages. Data were compared using analysis of Pearson Chi-square and Z test as appropriate. The level of statistical significance was set at $P< 0.05$.

## Results

### Types and frequencies of bacterial genera isolated from the contaminated samples

During the study period, a total of 243 swabs were investigated. There were 24.7% contaminated swabs that yielded bacterial genera. There were 64 bacterial isolates that were distributed between seven different bacterial genera: *Enterobacter* spp., *Escherichia coli*, *Klebsiella* spp., *Acinetobacter* spp., *Pseudomonas* spp., staphylococci including *S. aureus* and CoNS, and *Streptococcus* spp. (some were diagnosed to the species level) were isolated from the 60 contaminated samples. However, 4 contaminated samples yielded two different bacterial isolates (Table 1). The prevalence of Gram negative isolates (51.6%) were slightly higher than the isolation rate of Gram positive (48.4%).

**Table 1:** Types and frequency of bacteria isolated from contaminated samples

| Isolated bacteria | Public hospitals No (%) | Private hospitals No (%) | Total No (%) |
|---|---|---|---|
| *Enterobacter* spp. | 13 (20.3) | 2 (3.1) | 15 (23.4) |
| *Escherichia coli* | 5 (7.8) | 0 (0.0) | 5 (7.8) |
| *Klebsiella* spp. | 5 (7.8) | 0 (0.0) | 5 (7.8) |
| *Acinetobacter* spp. | 1 (1.6) | 4 (6.2) | 5 (7.8) |
| *Pseudomonas* spp. | 2 (3.1) | 1 (1.6) | 3 (4.7) |
| *Staphylococcus aureus* | 2 (3.1) | 1 (1.6) | 3 (4.7) |
| Coagulase negative staphylococci | 7 (10.9) | 19 (29.7) | 26 (40.6)* |
| *Streptococcus* spp. | 0 (0.0) | 2 (3.1) | 2 (3.1) |
| **Total (%)** | **35 (54.7)** | **27 (45.3)** | **64 (100)** |

* *P*-value < 0.05

The highest percentage of bacteria isolated were from the genus *Staphylococcus* (29, 45.3%), which was identified in samples from both public and private hospitals, although it was present at a higher rate in the private hospitals. Of these *Staphylococcus* species, 10.34% (3 out of 29) were *S. aureus,* and the remainder (89.7%, 26 out of 29) were CoNS. Among staphylococci, CoNS was the predominant and was significantly higher than *S. aureus* (*P*-value=0.009). The second-highest bacteria isolated were from the genus *Enterobacter* (15, 23.44%), with the highest rate being observed in the swabs collected from the public hospitals. The third-highest isolated bacteria were from the genera *Escherichia, Klebsiella* and *Acinetobacter* (5 isolates for each genus, 7.81%), whereas the genus *Pseudomonas* was identified in 3 samples (4.69%). Meanwhile, the bacterial isolates that were encountered the least were from the genus *Streptococcus* (2, 3.13%). The most common bacterial genera that were recovered are

*Staphylococcus* and *Enterobacter*, which together represented more than two thirds (68.75%) of all bacterial isolates (Table 1).

**Antimicrobial resistance pattern of isolated bacteria**

The rates of resistance of Gram negative and Gram positive isolates to a panel of antibiotics, which most of them are routinely used in our hospitals are shown in tables 2 and 3. About ninety four percent of Gram negative isolates were resistant to at least one antibiotic, whereas, 81.8% showed resistance to at least two antibiotics. Gram negative isolates showed the highest percentage of resistance to ampicillin and amoxicillin (93.9%), followed by beta lactamase inhibitors of these compounds, (ampicillin-sulbactam and ampicillin-clavulanic acid) and cefazolin (81.8%). However, the lowest resistance -which reach zero- was recorded against imipenem and tobramycin (0.0%), followed by amikacin (6.1%) and gentamicin (15.2%). *Enterobacter* spp. -as the predominant Gram negative contaminants-, showed 100% resistance to penicillin family, trimethoprim-sulfamethoxazole and the first-generation cephalosporin, cefazolin, while there was no any isolate resistant to imipenem, tobramycin, amikacin and ciprofloxacin. On the other hand, *Klebsiella* spp. showed the lowest resistant profile and was susceptible to most of antibiotic used, except for ampicillin and amoxicillin. *E. coli* displayed almost a similar resistance pattern but was resistant to ampicillin and amoxicillin in 60% of tested isolates. *P. aeruginosa* and *Acinetobacter* spp. showed the highest antibiotic resistance rate and was significantly resistant to most of the antibiotics used, especially penicillin family, trimethoprim-sulfamethoxazole, first and second generation cephalosporins (Table 2).

However, the third generation cephalosporin, ceftazidime which is active against *P. aeruginosa* was 100% effective, beside other pseudomonal antimicrobial agents such as piperacillin and tobramycin.

**Table 2:** Antimicrobial resistant pattern of gram negative isolates against commonly used antibiotics

| | **Types of tested bacteria** | | | | | |
|---|---|---|---|---|---|---|
| **Antibiotic** | ***Enterobacter* spp.** | ***E. coli*** | ***Klebsiella* spp.** | ***Acinetobacter* spp.** | ***P. aeruginosa*** | **Total** |
| Ampicillin | 100% | 60% | 100% | 100% | 100% | **93.9%** |
| Amp-Sulb | 100% | 60% | 40% | 80% | 100% | **81.8%** |
| Amoxicillin | 100% | 60% | 100% | 100% | 100% | **93.9%** |
| Amox-Clav | 100% | 60% | 40% | 80% | 100% | **81.8%** |
| Piperacillin | 66.7% | 20% | 40% | 60% | 00% | **48.5%** |
| Cefazolin | 100% | 40% | 40% | 100% | 100% | **81.8%** |
| Cefaclor | 66.7% | 40% | 20% | 100% | 100% | **63.6%** |
| Cefotaxime | 66.7% | 40% | 20% | 60% | 100% | **57.6%** |
| Ceftriaxone | 66.7% | 40% | 00% | 80% | 100% | **57.6%** |
| Cefoxitin | 66.7% | 40% | 20% | 60% | 100% | **57.6%** |
| Ceftazidime | 66.7% | 40% | 00% | 80% | 00% | **48.5%** |
| Imipenem | 00% | 00% | 00% | 00% | 00% | **00%** |
| Gentamycin | 00% | 00% | 00% | 80% | 33.3% | **15.2%** |
| Tobramycin | 00% | 00% | 00% | 00% | 00% | **00%** |
| Amikacin | 00% | 20% | 00% | 00% | 33.3% | **6.1%** |
| Ciprofloxacin | 00% | 60% | 00% | 80% | 66.7% | **27.3%** |
| SXT | 100% | 40% | 20% | 100% | 100% | **78.8%** |

Amp-Sulb: ampicillin-sulbactam; Amox-Clav: amoxicillin-clavulanic acid; SXT: trimethoprim-sulfamethoxazole

Resistance pattern of all 29 isolates of staphylococci including *S. aureus* and CoNS showed that there was no any isolate resistant to vancomycin (Table 3). Doxycycline, rifampin, ciprofloxacin, amikacin, trimethoprim-sulfamethoxazole and gentamicin were found to be effective antimicrobials with low resistance pattern of 3.4%, 3.4%, 24.1%, 27.6%, 41.4% and 44.8% respectively. However, high

resistant percentage was detected against penicillin (93.1%) and ampicillin (86.2%). Moderate resistance was found against erythromycin, clindamycin, oxacillin and the first generation cephalosporin, cefoxitin. The resistance pattern of CoNS was significantly higher than that of *S. aureus*, especially for the antibiotics trimethoprim-sulfamethoxazole, amikacin and ciprofloxacin (Table 3).

**Table 3:** Antimicrobial resistant pattern of staphylococci isolates against commonly used antibiotics

| | **Types of tested bacteria** | | |
|---|---|---|---|
| **Antibiotic** | **CoNS** | ***S. aureus*** | **Total** |
| Penicillin | 92.3% | 100% | **93.1%** |
| Ampicillin | 84.6% | 100% | **86.2%** |
| Oxacillin | 65.4% | 33.3% | **62.1%** |
| Vancomycin | 00% | 00% | **00%** |
| Erythromycin | 69.2% | 33.3% | **65.5%** |
| Clindamycin | 65.4% | 33.3% | **62.1%** |
| Gentamicin | 50% | 00% | **44.8%** |
| Cefoxitin | 65.4% | 33.3% | **62.1%** |
| Amikacin | 30.8% | 00% | **27.6%** |
| Doxycycline | 3.8% | 00% | **3.4%** |
| Ciprofloxacin | 26.9% | 00% | **24.1%** |
| Rifampin | 3.8% | 00% | **3.4%** |
| SXT | 46.2% | 00% | **41.4%** |

Table 4 shows the frequency of ESBL-producing and methicillin resistant isolates among Gram negative and staphylococci respectively. There were 9.1% isolates showed ESBL-production, where they are belong to *E. coli* and *Klebsiella* spp. Eighteen isolates of staphylococci (62.1%) were found resistant to oxacillin and

considered as methicillin resistant. There was higher MR-CoNS (65.4%) in comparison to MRSA (33.3%). However, this difference did not reach statistical significance (*P*-value > 0.05). About one third of CoNS (34.6%) were MS-CoNS, while two third of *S. aureus* (66.7%) were MSSA.

**Table 4:** Frequency of ESBL-producing among gram negative isolates and frequency of methicillin resistance among CoNS and *S. aureus*

| | **Gram negative isolates** | | | | | |
|---|---|---|---|---|---|---|
| | ***Enterobacter* spp.** | ***E. coli*** | ***Klebsiella* spp.** | ***Acinetobacter* spp.** | ***P. aeruginosa*** | **Total** |
| ESBL Positive | 0 (0%) | 2 (40%) | 1 (20%) | 0 (0%) | 0 (0%) | 3 (9.1%) |
| ESBL Negative | 15 (100%) | 3 (60%) | 4 (80%) | 5 (100%) | 3 (100%) | 30 (90.9%) |
| **Total** | 15 (100%) | 5 (100%) | 5 (100%) | 5 (100%) | 3 (100%) | 33 (100%) |

| | **staphylococci isolates** | | |
|---|---|---|---|
| | **CoNS** | ***S. aureus*** | **Total** |
| Methicillin resistant | 17 (65.4%)* | 1 (33.3%) | 18 (62.1%)* |
| Methicillin sensitive | 9 (34.6%) | 2 (66.7%) | 11 (37.9%) |
| **Total** | 26 (100%) | 3 (100%) | 29 (100%) |

* *P*-value > 0.05

## Discussion:

From the 60 contaminated swabs that were acquired in this study, 64 bacterial isolates were identified that were distributed over 7 bacterial genera. The highest number of contaminated samples contained

*Staphylococcus* spp. (45.31%), and most of these isolates (89.7%) were CoNS. This result is in agreement with other studies that have shown that CoNS are the most commonly isolated organisms from all sites in the operating-room environment (Duhaime, et al., 1991; Sehulster & Chinn, 2003; Edmiston, et al., 2005; Nelson, et al., 2006; Ensayef, et al., 2009). However, other studies have reported *S. aureus* as a contaminant isolated from postoperative wound infections (Ahmed, et al., 1998; Lilani, et al., 2005; Nelson, et al., 2006; Kownhar, et al., 2008). The Centers for Disease Control and Prevention (CDC) reports that in 1999, the most prevalent causes of SSIs were *S. aureus*, CoNS, *Enterococcus* species, and *E. coli*. A study published in 2003 reported that extremes of costs for SSIs may exceed $92,363 for patients with SSIs caused by MRSA (Nelson, et al., 2006). Number of studies in the literature indicates gradual increase in the emergence of antibiotic resistant microorganisms in surgical patients. Special interest in *S. aureus* surgical site infection is mainly due to its predominant role in hospital cross infection and emergence of virulent antibiotic resistant strains (Lilani, et al., 2005). In our present study, the antibiogram pattern of all *S. aureus* and CoNS isolates showed resistant to most of the common antibiotics tested, mainly penicillin and cephalosporin groups. This may complicates the problem and decrease the chances for antibiotic treatment. *S. aureus* is believed to originate from the patient's own anterior nares. So, most of SSIs could arise from the patient's own strain or as contaminant from the personnel especially surgeons. For this reason, it is important to control pre-operative nasal carriage of *S. aureus* to avoid the risk of MRSA in surgical wounds, which could possibly influence the outcome of SSIs (Kownhar, et al., 2008). It is noted that SSIs rate has varied from a low of 2.5 percent to a high of 41.9 percent, where these nosocomial surgical wound infections lengthen the hospitalization by an average of 7.4 days (Malik et al., 2011). Both CoNS and *S. aureus* are the most commonly implicated bacteria in SSIs (20% and 14% respectively). Consequently, CoNS is one of the most frequently isolated bacteria in the laboratory. These bacteria are of little virulence but are frequently implicated as the cause of infections in patients who are either immuno-compromised or have medical implants (Nelson, et al., 2006).

In this study, the number of samples contaminated with *E. coli*, which accounted for 7.8% of the isolates, was lower than the number reported in another study (62.5%) (Ensayef, et al., 2009); yet another study reported an even lower percentage than was detected in this study (4.8%) (Kownhar, et al., 2008). There are 40% of *E. coli* and 20% of *Klebsiella* spp. were identified as ESBL producers. Approximate findings were found in a study conducted by Gururajan *et al.,* who found about 47% of *E. coli* and 36% of *Klebsiella* species were identified as ESBL producers (Gururajan, et al., 2011). *E. coli* and *Klebsiella* spp. ESBL-producing strains are considered as an important finding of this study and should ring the alarm to fight against spreading of these strains of bacteria due to its dangerous and difficulty in treatment and control.

In addition*, Acinetobacter* spp. account for 7.8% of the contaminated samples. This prevalence rate is higher than that reported in a study by Kownhar *et al*., who found that 3.2% of positive isolates were *Acinetobacter* spp. (Kownhar, et al., 2008). *A. baumannii* has emerged as a serious agent of nosocomial and community-acquired infections. The increase in *A. baumannii* infections as a nosocomial pathogen is paralleled by its alarming development of resistance to antibiotics. The difficulty and sometimes the inability to eradicate this bacterial species in healthcare facilities, its inherent hardiness and its pattern of multidrug resistance to a wide range of antimicrobial agents has resulted in its emergence as a serious and dangerous nosocomial pathogen (Wybo, et al., 2007; Gootz & Marra, 2008). Some outbreaks have been documented with such multidrug resistant bacteria and others in our hospitals in Gaza strip; an outbreak of *A. baumannii* infection in the neonatal intensive care unit was happened in a governmental hospital in 2004 (Al Jarousha, et al., 2009). Also, another outbreak with the opportunistic pathogen *Serratia marcescens* was documented in 2005 (Al Jarousha, et al., 2008). *P. aeruginosa* accounts for 4.7%, while in Ensayef, *et al.,* study, it accounts for 30.4% in the year 2001 and 25.0% in the year 2002 (Ensayef, et al., 2009). Other studies also find higher rate of *P. aeruginosa* in SSIs but not in operation room equipment or environment (Rahman, et al., 2003; Nelson, et al., 2006). The high prevalence of *P. aeruginosa* may be due to the fact that it can survive well in moist environments, often

causing severe tissue damage due to its invasiveness. In our study, antibiogram pattern of *P. aeruginosa* isolates showed multi-drug resistant which again carry high risk for operated patients and others, especially immunocompromised and intensive care unit patients. Fortunately, all *P. aeruginosa* isolates were sensitive to the most used anti-pseudomonal antimicrobial agents as piperacillin, imipenem and tobramycin.

Antimicrobial resistance is increasing due to a variety of reasons, these include suboptimal use of antimicrobial agents for prophylaxis and treatment of infection, overuse or misuse, prolonged hospitalization, increased number and duration of intensive-care-unit stays, multiple co-morbidities in hospitalized patients, increased use of invasive devices and catheters, ineffective infection-control practices, noncompliance with infection-control practices, transfer of colonized patients from hospital to hospital, grouping of colonized patients in long-term-care facilities, antibiotic use in agriculture and animal, and increasing national and international travel (Osmon, 2001).

In this study, most of the isolates that tested found to be resistance to most of beta-lactam antibiotics tested, including penicillin group (amoxicillin and ampicillin) and first and second cephalosporin group (cefazolin, cefaclor, cefoxitin); whereas the third generation cephalosporins as ceftazidime showed moderately to highly activity against most isolates. Also, the trimethoprim-sulfamethoxazole showed low activity against most tested Gram negative bacterial isolates. So, penicillins and early cephalosporins should not be used as routine treatment in our hospitals.

However, the aminoglycoside antibiotic amikacin, showed high activity against all tested Gram negative isolates. In addition, doxycycline which has the same action as amikacin showed also high activity against tested Gram positive isolates. Moreover, the fluoroquinolone, ciprofloxacin showed high activity against most of tested bacterial isolates. These antimicrobials should substitute penicillins and early cephalosporins.

High resistance to penicillins and cephalosporins could be mainly due to excessive use and great prescription of these medication in Gaza for both hospital and community acquired infections and also in agriculture and animal feeding. Although, our findings showed that

other drugs such as amikacin, tobramycin, imipenem and vancomycin still have its full effectiveness against most of infections in our area, may be because they are not routinely and rarely prescribed for community and/or hospital acquired infections.

The main limitation of this study that anaerobic and/or fastidiously growing bacteria were not identified because the isolation of these bacteria requires special procedures and equipment which are not available. Also, other microbial contaminants, such as molds and yeasts, -which are beyond the scope of this study- were not investigated.

In conclusion, the above results showed moderate bacterial contamination in our operation theaters and high resistance pattern for most types of tested bacteria to many of commonly used antibiotics. This may decrease the alternatives of treatment and decrease the chance of fighting against those kinds of bacteria. Infection control measures should be targeted at these contaminations in our hospitals.

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