Original Research Article

Healthcare Associated Infections and Patterns of Antibiotic Resistance in Tropical Medicine Department in Egypt

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A B S T R A C T

Health-care-associated infection (HAI) is a major problem in hospitals worldwide. This study was conducted to describe culture-confirmed HAIs, its patterns of antibiotic resistance and risk factors for acquiring HAIs and multidrug resistant (MDR) pathogens. A retrospective analysis was made between January 2013 and August 2015 for HAIs among 7063 patients in tropical medicine department in Mansoura University Hospital, Egypt. A total of 1658 samples were collected for culture, isolation, identification and antibiotic susceptibility of nosocomial pathogens. Multidrug resistant pathogens were characterized phenotypically and extended spectrum β lactamase (ESBL) production was assessed by modified double disc synergy test (MDDS). HAI rate was 2.4/100 admission and 5.07/1000 patient days. The most common site of infection was urinary tract infection (UTI) (45.2%) and the most frequent nosocomial pathogen was E. coli (27.9%). Multidrug resistant organisms (MDRO) accounted for 40.6% of all bacterial isolates. The highest prevalence of ESBL production was among E. coli (47.6%). Age >65 years; invasive device utilization; neutropenia, abdominal paracentesis and hospital stay longer than seven days were significantly associated with HAI occurrence. Multiple antibiotic therapy, use of beta lactam, invasive device utilization and hospital stay longer than seven days were significantly associated with MDRO acquisition. The cumulative incidence of HAI in this study was low; however, the high rates of UTI and multi-resistant pathogens necessitate urgent comprehensive interventions of infection control.

Keywords
HAI, Multidrug resistant organisms, UTI, modified double disc synergy test (MDDS)

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Introduction

Health Care-associated Infection (HAI) is a term relating to an infection that is acquired during the delivery of health care that was not present or incubating at the time of admission. It includes infections acquired in a hospital but appearing after discharge. It also includes such infections among staff. HAI is a major problem in hospitals worldwide and the prevalence is two to three
fold higher in developing countries compared to Europeor USA. These infections are caused by a wide range of pathogens, and are associated with an increase in crude mortality, length of stay in the intensive care unit (ICU), and hospital costs.

Antimicrobial resistant pathogens causing HAIs pose an ongoing and increasing challenge to hospitals, both in the treatment of patients and in the prevention of the cross-transmission of these problematic pathogens. These pathogens include methicillin-resistant Staphylococcus aureus (MRSA), vancomycin resistant Enterococci (VRE), extended-spectrum β-lactamase (ESBL) producing Escherichia coli (E. coli) and Klebsiella species, and fluoroquinolone or carbapenem-resistant Enterobacteriaceae (CRE) or Pseudomonas aeruginosa (P. aeruginosa).

This retrospective study aimed at describing culture-confirmed HAIs, its patterns of antibiotic resistance and risk factors for acquiring HAIs and MDR pathogens in Mansoura University Tropical Medicine Department.

Subjects and Methods

A retrospective data analysis was made for HAIs in patients admitted to Tropical Medicine Department in Mansoura University Hospital. Seven hundred and sixty three (7063) patients were admitted between January 2013 and August 2015 corresponding to 33124 total inpatient days. A total of 1658 samples were collected from those patients who were suspected to have healthcare associated infections. Data of those patients were recruited from their files. The patients' samples included 1102 ascitic fluid (66.5%), 298 urine (18.0%), 174 blood (10.5%), 70 sputum samples (4.2%), 10 wound swabs (0.6%), and 4 stool samples (0.24%).

Microbiologic Studies

Samples were processed in Microbiology Diagnostics and Infection Control Unit (MDICU) in the Microbiology Department, Mansoura Faculty of Medicine using standard laboratory protocols. Antimicrobial susceptibility was determined by disc diffusion method as recommended by the Clinical and Laboratory Standards Institute. Isolates resistant to more than two different classes of antibiotics were considered as multidrug resistant (MDR).

Gram negative strains which showed a diameter of less than 27mm and 25mm for cefotaxime and ceftriaxone respectively were tested for ESBL production by the modified double disc synergy test (MDDS). MDDS was done by using a disc of amoxicillin-clavulanate (20/10 μg) along with four cephalosporins; 3GC- cefotaxime, ceftriaxone, cefpodoxime and one 4GC- cefepime. A lawn culture of the organisms was made on a Mueller-Hinton agar plate, as was recommended by CLSI 2009. A disc which contained amoxicillin-clavulanate (20/10 μg) was placed in the center of the plate. The discs of 3GC and 4GC were placed 15mm and 20mm apart respectively, center to center to that of the amoxicillin-clavulanate disc. Any distortion or increase in the zone towards the disc of amoxicillin-clavulanate disc was considered as positive for the ESBL production. K.pneumoniae 700603 was used as a positive control and E.coli 25922 was used as a negative control for the ESBL production.

Statistical Analysis

Data were analysed using the statistical package for social science (SPSS v16, Chicago, USA) program in Windows 7. The data were presented in the form of numbers and percentages. The infection rates were
calculated as cumulative incidence rate (the number of infections per 100 admitted patients) and incidence density (number of infections per 1000 patient days). Categorical data were analysed using chi-square tests to study the significance between 2 groups. The test was considered significant if $P$ value was < 0.05.

**Results and Discussion**

**HAI Rates**

There were 7063 patients admitted to the tropical medicine department during the study period. This represented 33124 total patient days of admission. Of the 7063 admissions, 121 (1.7%) developed culture confirmed HAI. Table (1) lists the infection rates during the study period.

**Distribution and Sites of Isolated Pathogens**

As shown in table (2), 45.2% of patients had isolates from urinary specimens (indwelling catheter or clean catch), 21.4% from peritoneal fluid (spontaneous bacterial peritonitis), 15.5% from respiratory specimens (sputum or pleural fluid), 14.3% from blood specimens (peripheral or central), and 2.4% from wound infections. *E. coli* was the commonest isolate (27.9%) and was most frequently isolated from urine specimens (55.3%), followed by *Candida* spp. (17.8%), then *Staphylococcus aureus* (*S. aureus*) (17.3%) which was most frequently isolated from blood specimens (34.5%).

Other isolates included *Klebsiella* spp. (10.7%) which was isolated most frequently from UTI (55.6%), *Proteus* spp. (6.5%), MRSA (4.8%), *P. aeruginosa* (3.6%), *S. pneumoniae* (4.2%), Enterococci (2.4%), *S. viridians* (2.4%), *S. epidermidis* and *Salmonella* spp. (1.2% each).

**Antibiotic Resistance Pattern of Isolated Organisms**

Regarding Gram positive bacteria Fig.1(a), high resistance was detected to ampicillin (84.6%), clindamycin (80%), ampicillin/sulbactam (66.7%) and amoxicillin clavulinate (58.3%). Fifty percent resistance was detected with erythromycin, azithromycin, Sulfametoxazole/trimethoprim and cephalothin. Around 38% resistance to ciprofloxacin, 10% resistance to imipenem. No resistance was detected to vancomycin. On the other hand, Gram negative bacteria Fig.1(b) showed higher resistance to ampicillin (94.1%), azteronam (90%), ceftriaxone (88.9%), norfloxacin (88.2%), ceftazidime (84.6%), ciprofloxacin (83.4%). Seventy five percent resistances were detected with cefotaxime, cefipime, and ampicillin/sulbactam. Fifty percent resistance was found with cefaclor. Relatively low resistance was found with amikacin (12%) and imipenem (14.3%).

Isolates resistant to more than two different classes of antibiotics were considered as MDR.[16] Table (3) shows the frequency of MDR organisms (MDROs) among total isolates. As whole MDROs accounted for 40.6% of total bacterial isolates (56/138). MRSA accounted for 21.6% of all *S. aureus* isolates, ESBL producing *Klebsiella* spp. represented 77.8% of all *Klebsiella* isolates, ESBL producing *E. coli* was 42.6% of all *E. coli* isolates, ESBL producing Proteus spp. accounted for 72.7% of all Proteus spp. isolates. Ceftazidime resistant *P. aeruginosa* represented 33.3% of all *P. aeruginosa* isolates, and CRE accounted for 5.1% of all *enterobacteriacea* isolates.

As shown in table (4), of the ESBL Gram negative bacilli (GNB) 47.6% were *E. coli*, 33.3% *Klebsiella* spp., and 19.1% *Proteus* spp. while the 4 isolates of CRE were *E. coli*. 
One half of MRSA isolates were from lower respiratory tract specimens and the other half were from peritoneal fluid specimens. Isolation of ESBL GNB was from urine (57.1%), blood (14.3%), peritoneal fluid (23.8%), and sputum (4.8%) samples. While all CRE and ceftazidime resistant Pseudomonas spp. were isolated from urine samples (100%).

**Risk Factors Associated with HAI**

The risk factors significantly associated with HAI occurrence were: age >65 years ($P<0.001$), invasive device utilization (vascular or urinary catheters) ($P<0.001$); neutropenia ($P=0.021$), abdominal paracentesis ($P=0.034$), and hospital stay longer than seven days ($P<0.001$), table (5). While, the risk factors significantly associated with infection with MDR pathogens were multiple antibiotic therapy ($P<0.001$), beta lactam use ($P=0.023$), invasive device utilization (vascular or urinary catheters) ($P=0.045$), and hospital stay longer than seven days ($P=0.037$), table (6).

HAI are infections that patients acquire while receiving treatment for medical or surgical conditions and are the most frequent adverse event during care delivery. The impact of HAI can result in prolonged hospital stay, long-term disability, and increased resistance of microorganisms to antimicrobial agents, a massive additional financial burden for the health system, patients and their families, and excess deaths. The most frequent site of infection in this study was UTI followed by SBP, and LRTI accounting for (45.2%), (21.4%) and (15.5%) respectively. Blood stream infection accounted for 14.3% of all infections. Wound infections represented (2.4%) of all infections. Different frequencies were detected by Scherbaum et al., who reported that, SSIs were the most frequent type of HAI (44%), followed by UTI (26%), BSI(20%) and other infections (11%). The low rate of SSI in our study is due to the fact that patients underwent surgeries were admitted to the gastroenterology center and not to the tropical medicine department and the cases of wound infection in this study were developed at the incision site of liver biopsy. Also the higher UTI rate in our study is due to that, most patients were catheterized with indwelling urinary catheter which is an independent risk factor for UTI occurrence.

On the other hand, our rates are much lower than that reported from the prevalence of HAI in resource-limited settings which was 15.5/100 patients, with the highest infection densities in intensive care (47.9/1000 patient/days). Also another study in a pediatric hospital in Cambodia found that, the overall HAI prevalence was 13.8/100 patients. The explanation for these contradictory results is that our study was limited to one department (with only 30 beds) with no ICU and not to a whole hospital. Also this study included only culture confirmed infections and not all infections.
In our study, *E. coli* was the commonest isolate (27.9%) and most commonly isolated from urine specimens (55.3%), followed by Candida spp. (17.8%), then *S. aureus* (17.3%) which was most frequently isolated from BSI (34.5%). Other pathogen included *Klebsiella* spp (10.7%) and was isolated frequently from UTI (55.6%).

Naidu *et al.*, [25] study in an adult ICU detected Gram negative bacteria were the commonest isolates.

In the present study the most common isolated pathogen from BSI was *S. aureus* (10/24=41.7%) followed by *Klebsiella* spp. (6/24=25%). As regards UTI, *E. coli* was the commonest isolate (26/76 =34.2%) followed by candida spp. (20/76=26.3%) (Table 2).

Differently, Ghadiri *et al.*, [26] found that CoNS (34.8%) and *E. coli* (29.4%) were the commonest isolates causing nosocomial BSI. Although *E. coli* was the most common Gram-negative bacilli isolated from nosocomial UTI patients but with nearly double the frequency detected by this study(66.7%).

These differences could be attributed to different sample size and different geographical distribution.

In this study, the antibiotic resistance profile of nosocomial Gram positive bacteria Fig.1(a), showed high resistance to ampicillin (84.6%), clindamycin (80%), ampicillin/ sulbactam (66.7%) and amoxicillin clavulinate (58.3%). Fifty percent resistance was detected with erythromycin, azithromycin, Sulfamethoxazole/ trimethoprim and cephalothin. The reason for resistance to these antibiotics could be mediated by their widespread use in the hospital and the community. Around 38% resistance to ciprofloxacin, 10% resistance to imipenem and no resistance was detected to vancomycin. Methicillin resistant *S. aureus* accounted for 21.6% (8/37) of all *S. aureus* isolates as detected by cefoxitin disc.

In agreement with our results, Ghadiri *et al.*, [26] found high resistance rate of CoNS to ampicillin(97.1%), erythromycin(42.8%), gentamicin(28.5%) and cephalothin (51.4%). But in contrast to our results they detected, higher resistance against vancomycin 4.4%, ciprofloxacin (57.1%) and imipenem (28.5%), but lower resistance against clindamycin (57.1%).

Matching with our results, another study limited to UTI cases in Tehran showed, high level of resistance to ampicillin was seen among *S. aureus, Enterococcus* and CoNS isolates from UTI, and All isolates were fully sensitive to vancomycin with the exception of Enterococcus spp. (11.9%).[27]

Gram negative bacteria showed higher resistance, ampicillin (94.1%), aztereonam (90%), ceftriaxone (88.9%), norfloxacin (88.2%), ceftazidime (84.6%), ciprofloxacin (83.4%), Fig.1(b). Seventy five percent resistances were detected with cefotaxime, cefipime, and ampicillin/sulbactam. Fifty percent resistance was found with cefaclor. Relatively low resistance was found with amikacin (12%) and imipenem (14.3%).

Christoff *et al.*, [28] analyzed the antibiotic susceptibility of 5000 Gram-negative rods isolated in the ICU and found near results to ours as regard the susceptibility to monotherapy of imipenem was 88.8% (resistance 11.2%). On the other hand, they detected higher susceptibility to ceftazidime (69.2%) than ours (15.4%).

Another study from India found the mean
resistance of GNB isolates from tracheal and bronchial specimens was: ampicillin (98.5% and 96.8%), cotrimoxazole (76.6% and 81.8%), gentamicin (81.8% and 95.6%) amikacin (53% and 44.1%), cefotaxime (82.6% and 89.9%), ceftriaxone (87.9% and 90.5%), ceftazidime (81.1% and 84.9%) and ciprofloxacin (75.3% and 86.7%). These results support ours with the exception of higher resistance to gentamicin and amikacin than ours.[29]

Our results declared that the frequency of MDROs (Table 3) was 40.6% among all bacterial isolates (56/138). Among all S. aureus isolates (37) detected in this study, eight were MRSA (21.6%). As regard ESBL production the overall ESBL GNB producers were 42/76 (55.3%), 14 of 18 (77.8%) Klebsiella spp., 20 of 47 (42.6%) E. coli, and 8 of 11 (72.7%) Proteus spp. Two of 6 (33.3%) P. aeruginosa strains were ceftazidime resistant, and 4 of 78 (5.1%) enterobacteriaceae isolates were carbapenem resistant. No imipenem resistant P. aeruginosa strains were detected.

One study by Stoesser et al.,[21] detected two of three (66.7%) S. aureus isolated were MRSA and 11 of 13 (85%) K. pneumonia isolates were ESBL producers and there was one imipenem-resistant P. aeruginosa isolate. Another study conducted at the National Public health laboratory, Kathmandu, Nepal reported that (31.57%) of E. coli were confirmed as ESBL producers.[30]

A lower detection rate for ESBL-GNB by a study done at a tertiary hospital in Mwanza, Tanzania, the overall prevalence of ESBLs in all GNB (377 clinical isolates) was (29%). The ESBL prevalence was 64% in K. pneumonia but (24%) in E. coli.[31] Fatemeh et al., found that (26.5%) of E. coli and (43%) of K. Pneumoniae were ESBL positive in a study conducted at the Imam Reza hospital of Mashhad, IR Iran. They indicated the high prevalence of ESBL producing Enterobacteriaceae family especially in inpatients.[32]

Supportive to our result by a study conducted in Egypt showed that 61% of E. coli produced ESBLs[33] and also many other studies reported high incidence of ESBL-E.coli and ESBL-K.pneumonia.[34-37]

Ceftazidime-resistant was detected in (33.3%) of P. aeruginosa. However, Hidron and colleagues reported lesser percentage of P. aeruginosa pathogenic isolates resistant to ceftazidime as (12.6%) with cases of catheter associated UTI, and (18.7%) with cases of central line associated BSI.[38]

The differences between these studies could be related to several factors including the different geographical area, the country, the hospital, the sample size and the strict adherence to infection control guidelines.

Risk factors for HAI vary according to the type of health-care facility and to the care area where the patient is admitted, and are partially different in developing countries. We found that, the most common risk factors associated with HAIs occurrence were: age >65 years; invasive device utilization (vascular or urinary catheters); neutropenia, abdominal paracentesis and hospital stay longer than seven days (Table 5).[39-43]

In this study, abdominal paracentesis was significantly associated with SBP. This is supported by another study which found that invasive procedures such as paracentesis, may introduce bacteria into the blood or directly into the peritoneal cavity and is a factor that may predispose a patient to the risk of developing SBP infection.[44]
Our results indicated that, the risk factors significantly associated with infection with MDR pathogens were multiple antibiotic therapy, beta lactam use, invasive device utilization (vascular or urinary catheters) and hospital stay longer than seven days (Table 6).

**Table 1** Rate of HAIs.

|                     | Total admission No. | 7063 |
|---------------------|---------------------|------|
|                     | Total patient days No. | 33124 |
|                     | Total cultures No.   | 1658 |
|                     | Positive cultures No. | 168  |
|                     | Infected patients No. | 121  |
| HAIR / 100 admissions |                     | 2.4  |
| HAIR/1000 patient days |                     | 5.07 |
| PIR / 100 admissions  |                     | 1.7  |
| PIR/1000 patient days|                     | 3.65 |

HAIR: Health care associated infection rate  
PIR: patient infection rate

**Table 2** Distribution of Nosocomial Pathogens in relation to the type of infection.

| Nosocomial pathogen          | LRTI No. (%) | BSI No. (%) | UTI No. (%) | SBP No. (%) | GE No. (%) | Wound infection No. (%) | Total No. (%) |
|------------------------------|--------------|-------------|-------------|-------------|-------------|-------------------------|---------------|
| Candida spp.                 | 10 (33.3)    | 0 (0.0)     | 20 (66.7)   | 0 (0.0)     | 0 (0.0)     | 0 (0.0)                 | 30 (17.8)     |
| S. aureus                    | 8 (27.6)     | 10 (34.5)   | 2 (6.9)     | 5 (17.2)    | 0 (0.0)     | 0 (0.0)                 | 29 (17.3)     |
| MRSA                         | 4 (50.0)     | 0 (0.0)     | 0 (0.0)     | 4 (50.0)    | 0 (0.0)     | 4 (13.8)                | 8 (4.8)       |
| S. epidermidis               | 0 (0.0)      | 2 (100)     | 0 (0.0)     | 0 (0.0)     | 0 (0.0)     | 0 (0.0)                 | 2 (1.2)       |
| Klebsiella spp.              | 2 (11.1)     | 6 (33.3)    | 10 (55.6)   | 0 (0.0)     | 0 (0.0)     | 0 (0.0)                 | 18 (10.7)     |
| P. aeruginosa                | 0 (0.0)      | 0 (0.0)     | 6 (100)     | 0 (0.0)     | 0 (0.0)     | 0 (0.0)                 | 6 (3.6)       |
| E. coli                      | 0 (0.0)      | 4 (8.5)     | 26 (55.3)   | 17 (36.2)   | 0 (0.0)     | 0 (0.0)                 | 47 (27.9)     |
| Proteus spp.                 | 0 (0.0)      | 0 (0.0)     | 8 (72.7)    | 3 (27.3)    | 0 (0.0)     | 0 (0.0)                 | 11 (6.5)      |
| Enterococci                  | 0 (0.0)      | 0 (0.0)     | 4 (100)     | 0 (0.0)     | 0 (0.0)     | 0 (0.0)                 | 4 (2.4)       |
| Streptococcus pneumonia      | 2 (28.6)     | 2 (28.6)    | 0 (0.0)     | 3 (42.8)    | 0 (0.0)     | 0 (0.0)                 | 7 (4.2)       |
| Streptococcus viridans       | 0 (0.0)      | 0 (0.0)     | 0 (0.0)     | 4 (100)     | 0 (0.0)     | 0 (0.0)                 | 4 (2.4)       |
| Salmonella spp.              | 0 (0.0)      | 0 (0.0)     | 0 (0.0)     | 0 (0.0)     | 2 (100)     | 0 (0.0)                 | 2 (1.2)       |
| Total                        | 26 (15.5)    | 24 (14.3)   | 76 (45.2)   | 36 (21.4)   | 2 (1.2)     | 4 (2.4)                 | 168 (100)     |

LRTI: lower respiratory tract infection, BSI: blood stream infection, UTI: urinary tract infection, SBP: spontaneous bacterial peritonitis, GE: gastroenteritis, MRSA: methicillin resistant *Staphylococcus aureus*
Table 3 Frequency of MDROs.

| Type of MDROs                  | No. of MDRO/total bacterial isolates (%) |
|-------------------------------|-----------------------------------------|
| MRSA                          | 8/37 (21.6%)                            |
| ESBL-GNB                      | 42/76 (55.3%)                           |
| • ESBL klebsiella spp.        | 14/18 (77.8%)                           |
| • ESBL E. coli                | 20/47 (42.6%)                           |
| • ESBL Proteus spp.           | 8/11 (72.7%)                            |
| Ceftazidimeresistant *Pseudomonas aeruginosa* | 2/6 (33.3%) |
| CRE                           | 4/78 (5.1%)                             |
| Total                         | 56/138 (40.6%)                          |

MDRO: multidrug resistant organisms, MRSA: methicillin resistant *S. aureus*, ESBL: extended spectrum beta lactamase, CRE: carbapenem resistant enterobacteriaceae.

Table 4 Distribution of MDROs among Bacterial Isolates and Clinical Specimens.

| Bacterial isolates No. (%) | MRSA          | ESBL GNB(N=42)                                      |
|----------------------------|---------------|----------------------------------------------------|
|                             |               | E. coli: 20/42 (47.6%)                              |
|                             |               | Klebsiella spp.: 14/42 (33.3%)                    |
|                             |               | Proteus spp.: 8/42 (19.1%)                         |
| CRE(N=4)                   |               | E. coli: 4/4 (100%)                                |
| Ceftazidime resistant *Pseudomonas aeruginosa* (N=2) |               | *Pseudomonas aeruginosa*: 2/2 (100%)             |

| Type of specimen No. (%)   | MRSA (N=8)     | ESBL GNB (N=42)                                     |
|----------------------------|----------------|---------------------------------------------------|
|                             | LRT: 4/8 (50.0%) | Urine: 24/42 (57.1%)                               |
|                             | SBP: 4/8 (50.0%)  | Blood: 6/42 (14.3%)                               |
|                             |                 | Peritoneal fluid: 10/42 (23.8%)                   |
|                             |                 | Sputum: 2/42 (4.8%)                               |
| CRE(N=4)                   |                 | Urine: 4/4 (100%)                                 |
| Ceftazidime resistant *Pseudomonas aeruginosa*(N=2) |                 | Urine: 2/2 (100%)                                |

ESBL GNB: extended spectrum beta lactamase producing Gram negative bacilli, CRE: carbapenem resistant enterobacteriaceae, MRSA: methicillin resistant *Staphylococcus aureus*, LRTI: lower respiratory tract infection, SBP: spontaneous bacterial peritonitis.
Figure (1): Antibiotic Resistance Patterns: (a) Gram positive pathogens. (b) Gram Negative pathogens
### Table 5: Risk Factors Associated with HAIs.

| Risk factor for nosocomial infections | No. of Patients with nosocomial infection (N=121) | Odd's ratio (95% CI) | P value |
|--------------------------------------|-----------------------------------------------|----------------------|---------|
| Age above 65 years                   | 74 (61.2%)                                    | 2.9 (2.04-4.18)      | < 0.001*|
| Invasive device utilization (vascular or urinary catheters) | 82 (67.8%)                                    | 3.3 (2.2-4.79)       | < 0.001*|
| Neutropenia                          | 33 (27.3%)                                    | 1.64 (1.01-2.47)     | 0.021*  |
| Haemodialysis                        | 10 (8.3%)                                     | 1.01 (0.53-2.01)     | 0.87    |
| Abdominal paracentesis               | 73 (60.3%)                                    | 1.51 (1.01-2.22)     | 0.034*  |
| Upper GIT endoscopy                  | 56 (46.3%)                                    | 1.03 (0.48-1.7)      | 0.89    |
| Liver biopsy                         | 28 (23.1%)                                    | 1.12 (0.62-1.92)     | 0.64    |
| hospital stay longer than 7 days     | 84 (69.4%)                                    | 1.93 (1.3-2.84)      | <0.001* |

*P value* < 0.05 is significant*

### Table 6: Risk Factors Associated infection with MDROs.

| Risk factor for infection with MDROs | No. of infected patients with multidrug resistant pathogens (N=42) | Odd's ratio (95% CI) | P value |
|-------------------------------------|------------------------------------------------------------------|----------------------|---------|
| Multiple antibiotic therapy         | 28 (66.7%)                                                       | 3.46 (1.4-8.65)      | < 0.001*|
| Beta-lactam use                     | 22 (52.3%)                                                       | 2.57 (1.05-6.34)     | 0.023*  |
| Invasive device utilization (vascular or urinary catheters) | 30 (71.4%)                                                       | 2.34 (0.94-5.92)     | 0.045*  |
| Haemodialysis                       | 10 (23.8%)                                                       | 1.03 (0.37-2.85)     | 0.96    |
| Hospital stay longer than 7 days    | 34 (81.0%)                                                       | 2.64 (0.96-7.46)     | 0.037*  |

*P value* < 0.05 is significant*

In agreement with our results, other studies reported that, patients at high risk for developing colonization or infection with ESBL-producing organisms are often seriously ill patients with prolonged hospital stays and in whom invasive medical devices are present (urinary catheters, endotracheal tubes, central venous lines) for a prolonged duration. In the median length of hospital stay prior to isolation of an ESBL producer has ranged from 11 to 67 days, depending on the study.

Our results are also supported by other studies that found a relationship between third-generation cephalosporin use and acquisition of an ESBL-producing strain. In contrast to our results, other studies detected hemodialysis as a risk factor for MDROs acquisition. These differences could be explained by differences in study populations, selection of cases, selection of controls, and sample size. This study has a
number of important limitations. It is a retrospective study that relies on previous data records for which accuracy and completeness cannot be validated. Data on the use of all devices over the study period were not available and so rates of nosocomial infection associated with specific device utilization over time could not be calculated. The data on outcome were also incomplete.

In conclusion, the result of this study revealed that HAIs represent a substantial threat for patients at the tropical medicine department in Mansoura University Hospital. The overall incidence rate of HAI was lower than in hospitals from other developing countries. A particular high risk of nosocomial UTI was found. Thus, interventions to decrease UTI by compliance to infection control guidelines during urinary catheter insertion and maintenance should start here. Many of the identified pathogens, particularly the GNB have developed resistance to commonly prescribed antibiotics. Therefore, interventions to reduce the rate of multi-resistant pathogens have to be taken by appropriate use of antibiotic medications in the hospital setting. We also showed that surveillance of nosocomial infections is mandatory to reduce HAI and improve patient outcome.

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