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Full Length Research Paper

Assessing the frequency and antibiotic resistance of nosocomial bacterial infections in the intensive care units and general wards

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Considering the perpetual existence of resistant bacteria in different wards of hospitals, particularly the intensive care unit (ICU), as well as the hindrance they cause against therapy make it necessary to have comprehensive knowledge of these bacteria and their respective pattern of antibiotic resistance in different communities. This study was conducted to determine the pattern of antibiotic resistance for common bacteria in general wards and the intensive care unit of our hospital. This is a cross-sectional, descriptive study conducted from October 2009 through October 2010, in Madaen Hospital, Tehran. Standard sampling was performed for biologic fluids, wounds and devices associated with patients such as nozzle of the suction unit, endotracheal tube, central venous pressure catheter etc. A total number of 692 samples were administered to the microbiology department of the hospital, to be cultured on selective and then differential media. Once the bacteria were distinguished, their sensitivity for antibiotics was studied. From the total of 692 specimens, 192 pertained to patients in the intensive care unit, and 500 were obtained from patients in the general wards. Gram positive bacteria and fungi were more frequent in the ICU, whereas Gram negative bacteria were more frequently found in the general wards (p=0.001). The most common bacteria found in the ICU and general wards were *Klebsiella* (22.4%) and *Escherichia coli* (31.6%), respectively. In the ICU, the most frequent resistance was observed against Ceftazidime (87.9%), while the lowest resistance was against Vancomycin (7.7%). In general wards, Ceftriaxone indicated the greatest resistance (78.6%), with Vancomycin having the lowest resistance observed (9%). The antibiotic resistance against most antibiotics was significantly higher in the ICU compared to general wards (p=0.01). The findings of this study indicate that many Gram positive and negative bacteria are frequently encountered in the ICU. In addition, antibiotic resistance, particularly multi-drug resistance, is frequent among microorganisms of the ICU, as well as the general wards.

Key words: Intensive care unit, general ward, bacterial infection, antibiotic resistance.

INTRODUCTION

The term nosocomial infection first came to use in 1960. Nowadays, it is used to refer to infections which arise during or following hospital stay after 48 h. It manifests by fever, hypothermia, disorders in mental status, leukocytosis, leucopenia, oliguria, tachypnea, hypotension or tachycardia. Nosocomial infection constitutes an important cause of death, as well as increasing the length of hospital stay and medical costs (Barnett et al., 2011). As reported by the American center for disease control, 5 to 10% of patients admitted in hospitals of the United States contract new diseases

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during their stay, resulting in 90,000 cases of mortality per year (Weinstein, 2005). Studies conducted in England present nosocomial infections to be the fourth common cause of death, only topped by cardiac disease, stroke and cancer, with a prevalence of 3.6 to 17.6 in 1000 patients (Weinstein, 2005). Current data indicate the following as the most frequent sites of infection: urinary tract, surgical wounds, lower respiratory tract, and skin (Ghaznavi-Rad et al., 2010). The most common infective agents include viruses, bacteria, fungi, and protozoa, which present as organic or epidemic (Babcock et al., 2003). Introduction of antibiotics has rapidly lowered mortality caused by nosocomial infections; however, it has failed to affect the frequency of such infections. The reason lies in the unceasing evolution of bacteria which has existed since the first antibiotics were administered, and the rules of natural selection preserve the bacteria resistance against our antibiotics. The uncontrolled use of antibiotics during the last decade has brought about many problems such as intoxication and, particularly, rises of resistance strains, resulting in reduced efficiency of antibiotic agents (Barnett et al., 2011; Weinstein, 2005).

Different studies indicate that 20% of nosocomial infections occur with debilitating diseases (Tasota et al., 1998; Gould and Carlet, 2000). It is demonstrated by the fact that the rate of nosocomial infection in the intensive care unit, comprising only 5% of hospital beds, is 5 to 10 times higher compared to the general wards (Tasota et al., 1998; Tumer, 1993; Vosylius et al., 2003). Since the patients in the ICU are relatively immunocompromised as a result of different therapeutic methods, they are especially vulnerable to infection. Thus, the more antibiotics are administered to them, the higher will be their antibiotic resistance, forming a vicious cycle in these patients (Gould and Carlet, 2000). Bacterial drug resistance in the ICU is rising in Iran, whether *in vivo* or *in vitro* (Ghaznavi-Rad et al., 2010). Therefore, we conducted this study to compare antibiotic resistance of bacterial infections between general wards and the intensive care unit of Madaen Hospital, Iran in 2009 to 2010.

MATERIALS AND METHODS

In a cross-sectional descriptive study in Madaen Hospital (from October 2009 through October 2010), 377 patients, who had developed fever or symptoms of infection in a particular site after 48 to 72 h of admission were evaluated. Of the evaluated patients, 280 were from general wards and the remainder 97, were from intensive care unit (ICU). This evaluation comprised 692 specimens such as biologic fluids (urine, cerebrospinal fluid, ascitic fluid, peritoneal fluid, pleural fluid etc.), sputum, feces, devices associated with patients (Foley catheter, endotracheal tube, dialysis catheter etc.), wound discharges (abscess, surgical site, abdominal fistula etc.), and cranial, bronchial, crural, vaginal and testicular discharges. The specimens were dispatched to the laboratory under sterile conditions and according to standard protocols to be cultured on selective media. Urine was cultured on blood agar and eosin methylene blue (EMB) agar, feces on Selenit F and S.S. agar, and other specimens on blood agar, EMB agar, and chocolate agar with an enriched medium such as thioglycolate under aerobic conditions. The cultures were incubated for 24 to 48 h. Thereafter, macroscopic and microscopic features of the cultured colonies were evaluated and specialized media were utilized to determine the identity of microorganisms. These media included mannitol salt agar, coagulase, and DNase for Gram positive staphylococci; NaCl and Bile esculin for Gram positive streptococci, and citrate, urea and TSI for Gram negative bacteria. We defined polymicrobial culture as one containing at least 2 microorganisms (bacteria or fungi).

Determining antibiotic resistance

Once the bacteria were identified, antibiograms were determined using the diffusion method on the Mueller-Hinton agar medium. In this method, a suspension of bacteria in sterile physiologic serum was prepared with a turbidity of 0.5 McFarland. Subsequently, a sterile swap smeared with the bacterial suspension streaked the entire surface of a Mueller-Hinton agar plate in all directions close to a burner's flame. The disc was inserted and the whole apparatus incubated for 18 to 24 h; afterwards, the diameter of halo of non-growth around each disc was measured and compared to standard tables and the results were recorded as "sensitive", "relatively resistant", and "resistant" (Baron and Finegold, 1990). We used about 9 antibiotic discs for each bacterium. The antibiotics used for both Gram positive and negative bacteria included: Gentamicin, Cephalexin, Ceftizoxim, Amikacin, Co-trimoxazole, and Ofloxacin. The antibiotics Ciprofloxacin, Norfloxacin, Ceftriaxone, Ceftazidime and Cefotaxime were used specifically for Gram negative bacteria. The antibiotics Vancomycin, Doxycycline, and Erythromycin were used specifically for Gram positive bacteria.

Statistical analysis

Continuous and categorical data were analyzed for significance using one-way analysis of variance and chi-square tests, respectively. Student's *t*-test was used to determine significant differences with variables normally distributed; when not, a non-parametric Mann–Whitney *U*-test was carried-out. Statistical analysis of the data was performed with the Statistical Package for Social Sciences (version 16.0 for Windows; SPSS, Inc., Chicago, IL).

RESULTS

The average age of patients was 63.15±18.4 years (minimum 6 months and maximum 97 years) in the ICU and 56.17±21.4 years (minimum 15 days and maximum 94 years) in the general wards. The total average age was 59.13±20.83 years for the entire patients. From the total number of 692 specimens, 192 pertained to patients in the ICU and 500 pertained to patients of the general wards. Table 1 depicts the distribution of frequency for clinical specimens of patients based on their ward. The

Table 1. Frequency distribution of clinical specimens of patients according the ward.

Clinical specimens	General wards N (%)	ICU N (%)	Total N (%)
Biologic Liquid	18 (3.6)	9 (4.7)	27 (3.9)
Urine	268 (53.6)	43 (22.4)	311 (44.9)
Sputum	84 (16.8)	61 (31.8)	145 (21)
Devices associated with patient	73 (14.6)	68 (35.4)	141 (20.4)
Wound	52 (10.4)	11 (5.7)	63 (9.1)
Discharge	5 (1)	0)0)	5 (7)

ICU (intensive care unit).

Table 2. Frequency distribution of nosocomial pathogens according the wards.

Pathogen	General wards N (%)	ICU N (%)	P value
Gram positive bacteria	131 (26.2)	52 (27.1)	
Gram negative bacteria	317 (63.4)	101 (52)	0.001*
Fungi	52 (10.4)	39 (20.3)	

* P<0.05 is significant.

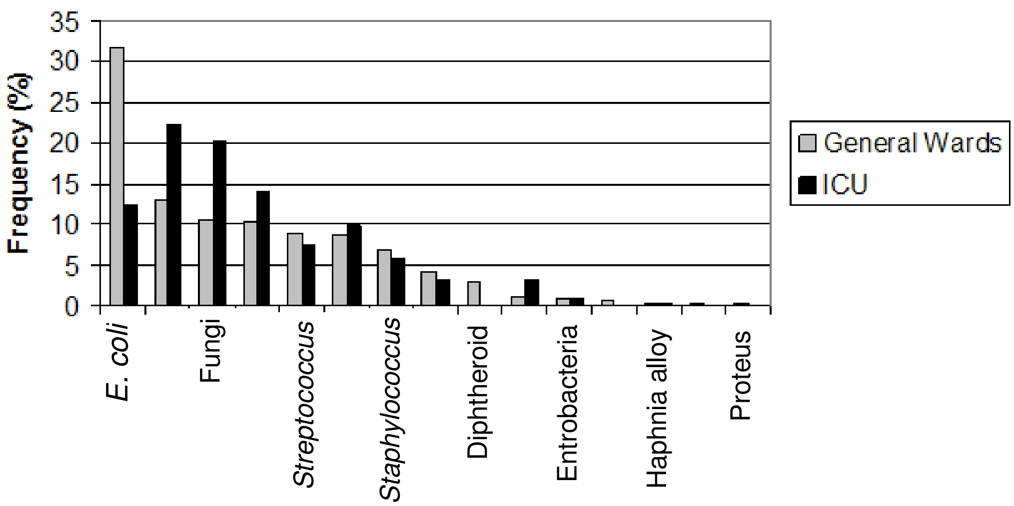

Figure 1. Frequency distribution of pathogens in the intensive care unit (ICU) and general wards.

most frequent specimen was urine sample (53.6%) in the general wards and devices associated with patients (35.4%) in the ICU, which in turn was most frequently comprised of Foley catheter (72.05%), central venous pressure catheter (CVP, 8.7%) and dialysis catheter (8.14%). The frequency of multibacterial specimens was 10.3 and 9.6% for the ICU and general wards, respectively. Table 2 presents the distribution of frequency for nosocomial pathogens based on the wards. As the table indicates, Gram positive bacteria and fungi are more frequent in the ICU, whereas Gram negative bacteria are more frequent in the general wards (p<0.001). Figure 1 illustrates the distribution of frequency of pathogens in the ICU and the general wards. As is evident from the figure, *Morganella*, *Proteus*, *Diphtheroid Bacillus* and *Salmonella* were not observed in the ICU. The most frequent pathogen was *Klebsiella* (22.4%) in the ICU and *Escherichia coli* (31.6%) in the general wards. Table 3 summarizes the distribution of frequency of bacterial reaction to antibiotics of the study.

Our findings indicate the greatest resistances of Gram negative bacteria belong to Cefotaxime (80.2%) and the least resistance of Gram positive bacteria belongs to Vancomycin (8.6%). Furthermore, the greatest sensitivity

Table 3. Frequency of bacterial reaction to study antibiotics.

Antibiotic	Intermediate resistance N (%)	Resistance N (%)	Sensitivity N (%)
Amikacin	157 (26.2)	232 (38.7)	211 (35.2)
Cephalexin	47 (7.8)	417 (69.5)	136 (22.7)
Ceftizoxim	24 (4)	375 (62.5)	201 (33.5)
Gentamicin	123 (20.5)	356 (59.3)	121 (20.2)
Co-trimoxazole	39 (6.5)	418 (69.7)	143 (23.8)
Ofloxacin	39 (6.5)	376 (63)	182 (30.5)
Ciprofloxacin	26 (6.5)	211 (52.5)	165 (41)
Cefotaxime	2 (2.3)	69 (80.2)	15 (17.4)
Ceftriaxone	3 (2.4)	97 (77.6)	25 (20)
Norfloxacin	22 (12.6)	101 (57.7)	52 (29.7)
Ceftazidime	15 (9.6)	113 (72)	29 (18.5)
Nalidixic acid	23 (9.3)	53 (62.2)	70 (28.5)
Nitrofurantoin	24 (9.7)	92 (37.1)	132 (53.2)
Vancomycin	26 (13.2)	17 (8.6)	154 (78.2)
Erythromycin	15 (7.6)	142 (72.1)	40 (20.3)
Doxycycline	19 (9.6)	131 (66.5)	47 (23.9)

Table 4. Frequency of bacterial reaction to study antibiotics in the ICU and general wards.

Antibiotic	ICU			General ward			P-value
	Intermediate resistance N (%)	Resistance N (%)	Sensitivity N (%)	Intermediate resistance N (%)	Resistance N (%)	Sensitivity N (%)	
Amikacin	27 (17.6)	83 (54.2)	43 (28.1)	130 (29.1)	149 (33.3)	168 (37.6)	0.0001
Cephalexin	6 (3.9)	132 (86.3)	15 (9.8)	41 (9.2)	285 (63.8)	121 (27.1)	0.0001
Ceftizoxim	7 (4.6)	124 (81)	22(14.4)	17 (3.8)	251 (56.2)	179 (40)	0.0001
Gentamicin	18 (11.8)	114 (74.5)	21 (13.7)	105 (23.5)	242 (54.1)	100 (22.4)	0.0001
Co-trimoxazole	13 (8.5)	113 (73.9)	27 (17.6)	26 (5.8)	305 (68.2)	116 (26)	0.0001
Ofloxacin	10 (6.6)	119 (78.3)	23 (15.1)	29 (6.5)	257 (57.8)	159 (35.7)	0.0001
Ciprofloxacin	13 (12.7)	70 (68.6)	19 (18.6)	13 (4.3)	141 (47)	146 (48.7)	0.0001
Cefotaxime	0 (0)	25 (83.3)	5 (16.7)	2 (3.6)	44 (78.6)	10 (17.9)	0.56
Ceftriaxone	1 (2.1)	41 (85.4)	6 (12.5)	2 (2.6)	56 (72.7)	19 (24.7)	0.24
Norfloxacin	12 (19.4)	40 (64.5)	10 (16.1)	10 (8.8)	61 (54)	42 (37.2)	0.006
Ceftazidime	1 (1.7)	51 (87.9)	6 (10.3)	14 (14.1)	62 (62.6)	23 (23.2)	0.002
Nalidixic acid	3 (7.1)	35 (83.3)	4 (9.5)	20 (9.8)	118 (57.8)	66 (32.4)	0.006
Nitrofurantoin	6 (14.3)	24 (57.1)	12 (28.6)	18 (8.7)	68 (33)	120 (58.3)	0.002
Vancomycin	7 (13.5)	4 (7.7)	41 (78.8)	19 (13.1)	13 (9)	113 (77.9)	0.961
Erythromycin	3 (5.8)	41 (78.8)	8 (15.4)	12 (8.3)	101 (69.7)	32 (22.1)	0.448
Doxycycline	5 (9.6)	38 (73.1)	9 (17.3)	14 (9.7)	93 (64.1)	38 (26.2)	0.421

of Gram positive bacteria were observed in the cases of Vancomycin (78.2%) and the least sensitivity of Gram negative bacteria were in cases of Ceftazidime (18.5%). Table 4 indicates the distribution of frequency of bacterial reaction in the ICU and general wards against antibiotics used in the study. The findings indicate that in the ICU, Ceftazidime has the greatest resistance (87.9%) and Vancomycin has the least resistance (7.7%). As for the general wards, the greatest antibiotic resistance was observed for Cefotaxime (78.6%), while Vancomycin had the least resistance (9%). As shown in Table 4, resistance against most antibiotics is significantly higher in general wards compared to the ICU (($p<0.01$). Figures 2, 3, 4, 5 and 6 depict the pattern of antibiotic resistance

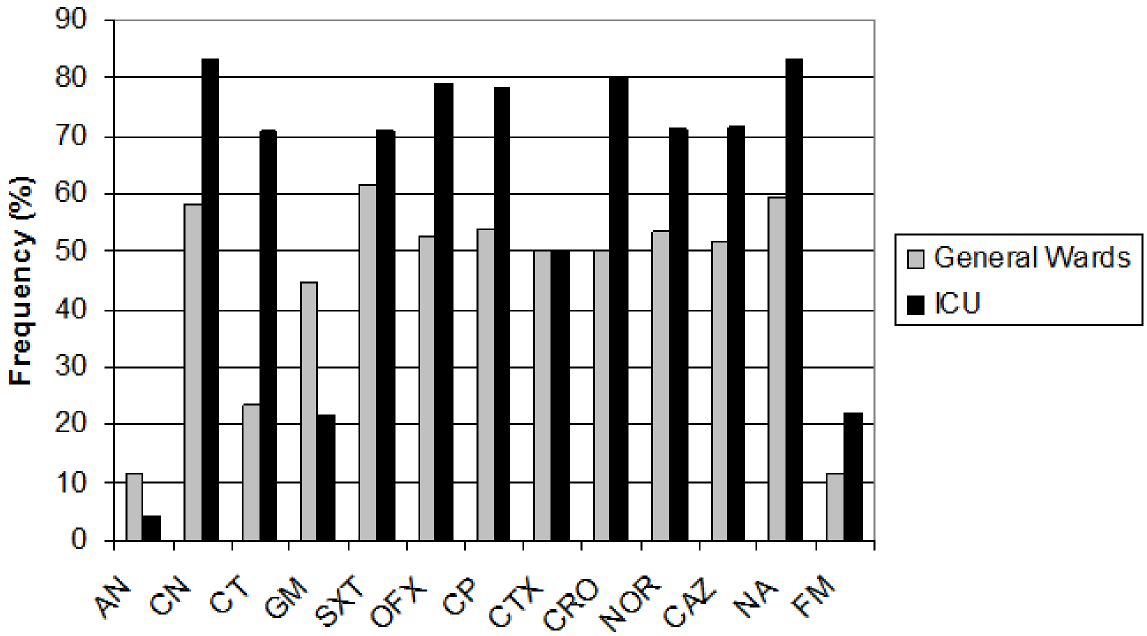

Figure 2. Pattern of antibiotic resistance for the *E. coli* in the general wards and intensive care unit (ICU). AN, Amikacin; CN, Cephalexin; CT, Ceftizoxim; GM, Gentamicin; SXT, Cotrimazole; OFX, Ofloxacin; CP, Ciprofloxacin; CTX, Cefotaxime; CRO, Ceftriaxone; NOR, Norfloxacin; CAZ, Ceftazidime; NA, Nalidixic acid; FM, Nitrofurantoin.

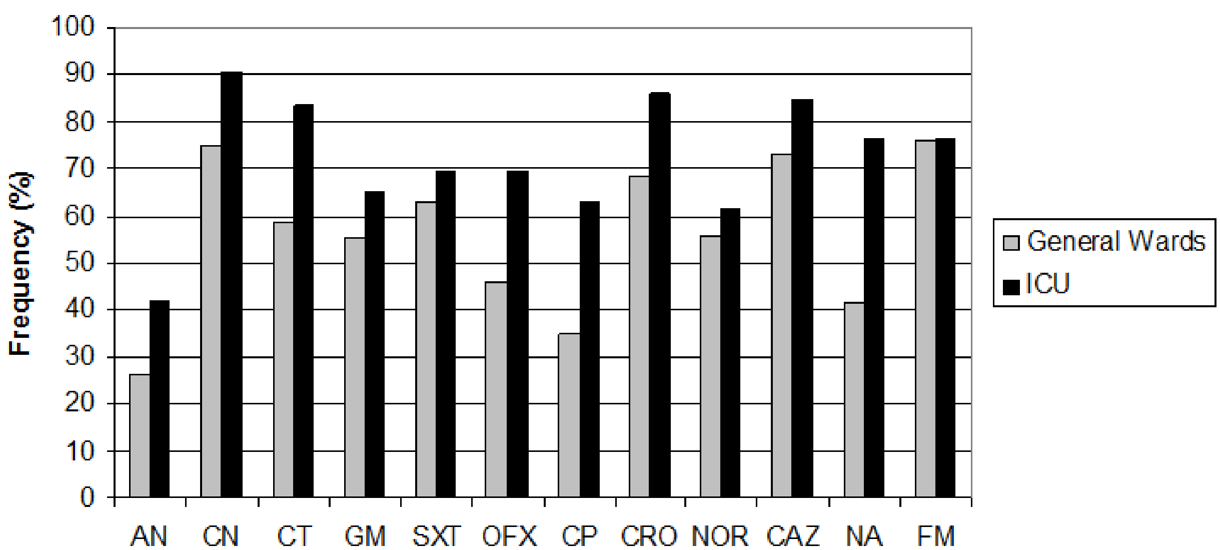

Figure 3. Pattern of antibiotic resistance for the *Klebsiella* in the general wards and intensive care unit (ICU). AN, Amikacin; CN, Cephalexin; CT, Ceftizoxim; GM, Gentamicin; SXT, Cotrimazole; OFX, Ofloxacin; CP, Ciprofloxacin; CTX, Cefotaxime; CRO, Ceftriaxone; NOR, Norfloxacin; CAZ, Ceftazidime; NA, Nalidixic acid; FM, Nitrofurantoin.

for the most frequent bacteria in the general wards and the ICU respectively. As these figures demonstrate, *E. coli* of the ICU is more resistant to all antibiotics (except Amikacin) compared to the *E. coli* of the general wards. Moreover, the *Klebsiella* isolated from the ICU is more resistant to all antibiotics in comparison with the same bacteria found in the general wards. The same is true for the case of *Staphylococcus aureus* which is more

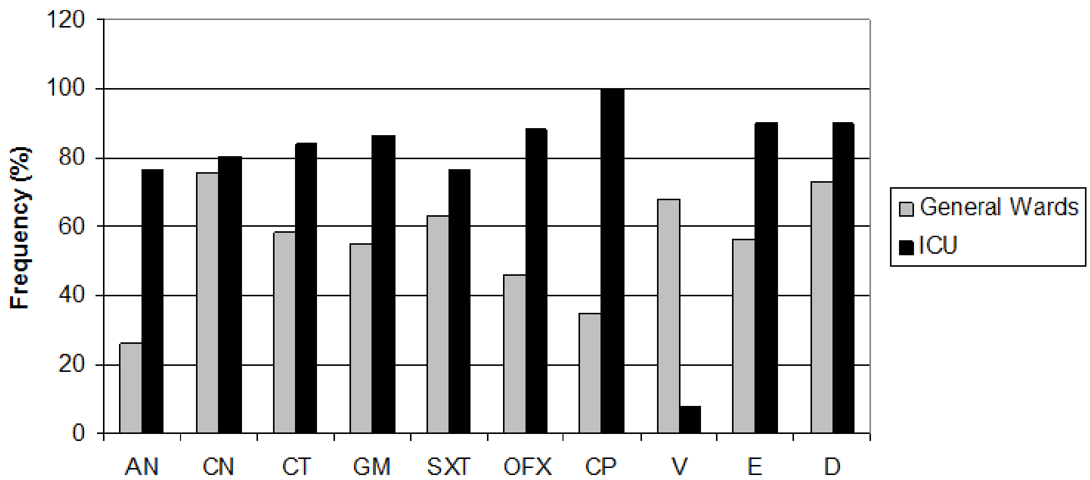

Figure 4. Pattern of antibiotic resistance for the *Staphylococcus aureus* in the general wards and intensive care unit (ICU). AN, Amikacin; CN, Cephalexin; CT, Ceftizoxim; GM, Gentamicin; SXT, Cotrimazole; OFX, Ofloxacin; CP, Ciprofloxacin; V, Vancomycin; E, Erythromycin; D, Doxycycline.

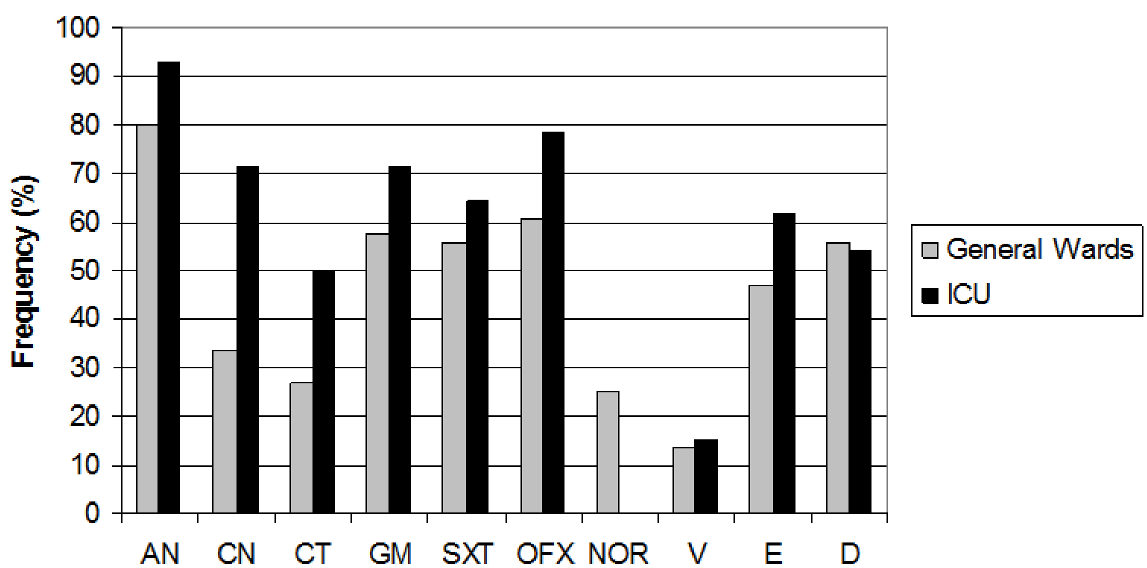

Figure 5. Pattern of antibiotic resistance for the *Streptococcus* in the general wards and intensive care unit (ICU). AN, Amikacin; CN, Cephalexin; CT, Ceftizoxim; GM, Gentamicin; SXT, Cotrimazole; OFX, Ofloxacin; NOR, Norfloxacin; V, Vancomycin; E, Erythromycin; D, Doxycycline.

resistant to all antibiotics (except Amikacin) in the ICU than in the general wards. In addition, *Streptococcus* of the ICU indicates greater resistance to all antibiotics of the study (except Norfloxacin) compared to its counterpart in the general wards. Another example is illustrated by *Pseudomonas* which is more resistant to all antibiotics of the study (except Amikacin) in the ICU compared to *Pseudomonas* of the general wards. In the ICU, *E. coli* was most sensitive to Amikacin (58.3%) and least sensitive to Cephalexin (4.2%). *Klebsiella* was most sensitive to Amikacin (34.9%) and least sensitive to Erythromycin and Doxycycline (0%). *S. aureus* indicated its greatest sensitivity to Vancomycin (74.1%) and least sensitivity to Ciprofloxacin (0%). *Streptococcus* was most sensitive to Vancomycin (76.9%) and least sensitive to Ciprofloxacin and Norfloxacin (0%). *Pseudomonas* was most sensitive to Amikacin (21%) and its sensitivity to other antibiotics was zero or less than 5%. In the general

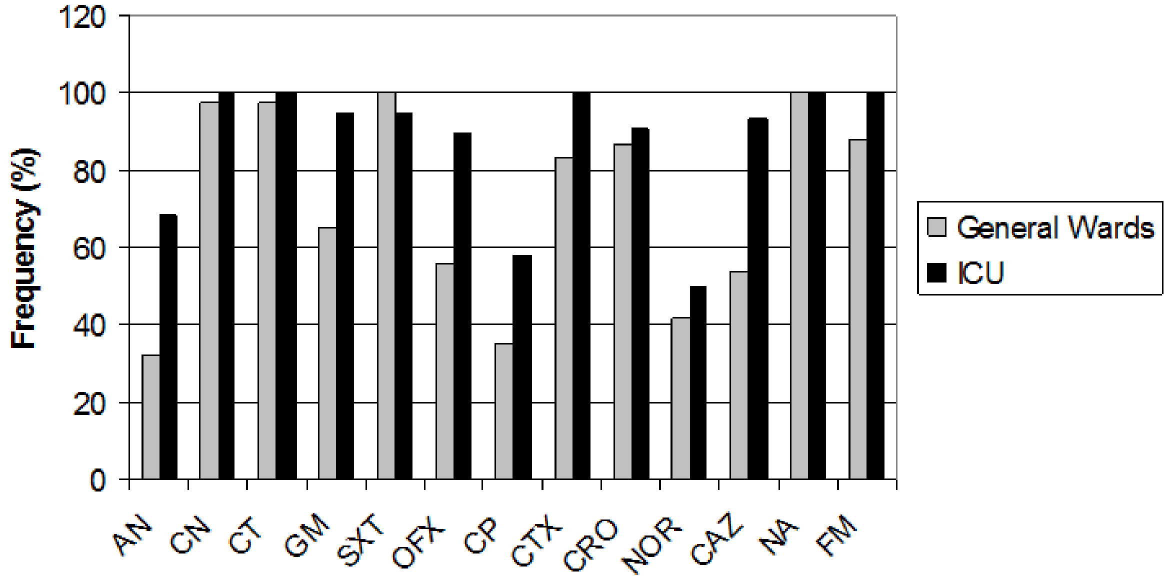

Figure 6. Pattern of antibiotic resistance for the *Peudomonas* in the general wards and intensive care unit (ICU). AN, Amikacin; CN, Cephalexin; CT, Ceftizoxim; GM, Gentamicin; SXT, Cotrimazole; OFX, Ofloxacin; CP, Ciprofloxacin; CTX, Cefotaxime; CRO, Ceftriaxone; NOR, Norfloxacin; CAZ, Ceftazidime; NA, Nalidixic acid; FM, Nitrofurantoin.

wards, *E. coli* was most sensitive to Nitrofurantoin (80.2%) and least sensitive to Gentamicin (24.8%). *Klebsiella* was most sensitive to Ciprofloxacin (58.7%) and least sensitive to Ceftazidime (11.5%). *S. aureus* was most sensitive to Nalidixic acid and Nitrofurantoin (100%) and least sensitive to Ciprofloxacin, Cefotaxime and Norfloxacin (0%). *Streptococcus* was most sensitive to Ceftazidime (0%). *Pseudomonas* was most sensitive to Amikacin (55.8%) while its sensitivity for Cephalexin, Co-trimoxazole and Nalidixic acid was 0%.

In this study, Gram negative bacteria constituted the most frequent pathogen in the ICU (more than 50%). The most frequent bacterium in the ICU was *Klebsiella*, followed by *Staphylococcus*, *E. coli* and *Pseudomonas*. In the general wards, Gram negative bacteria were more frequent (more than 60%), followed by Gram positive bacteria and fungi. The most frequent bacteria included *E. coli*, and subsequently, *Klebsiella, S. aureus,* and *Streptococcus*. Bacteria from the ICU demonstrated resistance against 15 out of 16 antibiotics (54 to 87%) which was greatest for Cephalexin, followed by Cefotaxime and Ceftriaxone, while the lowest resistance was observed against Vancomycin. General wards illustrated resistance against all antibiotics (33 to 78%), which was greatest against Cefotaxime and least against Vancomycin. Evaluation of the pattern of antibiotic resistance for the common bacteria of the ICU and general wards indicated that in the ICU, *E. coli, Klebsiella, S. aureus, Streptococcus* and *Pseudomonas* showed greater resistance against antibiotics compared to their counterparts in the general wards.

DISCUSSION

Numerous studies have indicated a different range of bacterial sensitivity and resistance to antibiotics for patients in the ICU compared to those in the general wards or on outpatient therapy. This difference arises from a multitude of factors, including the severity of diseases in the ICU, endemicity of resistant pathogen, and frequent use of antibiotics for treating these patients (Streite et al., 2004; Fridkin et al., 2001). Previous studies suggest that Gram negative bacteria comprise about half of pathogens in the ICU (Krajewska-Kułak et al., 2007). According to SENTRY project, 8 out of 11 frequent pathogens of the ICU are Gram negative bacteria (Streite et al., 2004). The most frequent of these bacteria include *S. aureus, Pseudomonas, E. coli*, and *Klebsiella*. These findings accentuate the importance of assessing Gram negative antibiotic resistance in the ICU (Rhomberg et al., 2006). A study in Carolinska Hospital, identified 27 bacteria in the general wards with *E. coli* (21%), *S. aureus* (15%), coagulase negative *Staphylococcus* (13%), *Enterococcus* (10%) and *Streptococcus* (4.5%) as the most frequent pathogens (Sörberg et al., 2003). In another study conducted in a hospital in Bushehr, Iran, 9 microbial agents were identified, among which

Pseudomonas (25.6%), *Acetinobacter* (19.7%), *E. coli* (13.3%), and *Klebsiella* (11.3%) proved the most frequent (Vahdat et al., 2004). Our study identified 14 bacterial agents in the general wards and 10 bacterial agents in the ICU. Generally speaking, different studies conducted for evaluation of nosocomial infections have yielded different microorganisms with different frequencies; it follows that each hospital is unique in its organisms which differ according to the different environmental conditions. Factors such as number of wards, number of ill patients, existence of hematology and transplant wards, methods of sterilization, number of personnel etc, cause discrepancies in the type and frequency of microorganisms identified, which is quite expectable in our study.

Our study observed fungal infections to be significantly higher in the ICU compared to the general wards (20 vs. 10%). An important issue which threatens most hospitals is the augmentation of opportunistic fungal infections, which is mainly caused by entry of fungal spores from the surrounding environment (Mishra et al., 1992). Nowadays, extensive use of immunosuppressive agents, broad-spectrum antibiotics, open surgeries of the viscera etc. have contributed to fungal infections in wards such as the ICU and transplant wards. Krajewska-Kułak et al.'s study of the indoor air and walls contamination of fungi at the Kavala Hospital in Greece (Krajewska-Kułak et al., 2007), found that the main fungal pathogen isolated from the air samples was *Candida albicans*. Our findings indicate that the specimens in the ICU are most frequently from devices associated with patients, with a significantly higher frequency compared to the general wards. Among the devices in the ICU, Foley catheters provided the greatest number of specimens. Urinary tract infection (UTI) is the single most common hospital-acquired infection, and the majority of cases of nosocomial UTI are associated with an indwelling urinary catheter. In general, 80% of urinary tract infections are reportedly due to catheterization. Women, the elderly, diabetic patients, ill patients and malnourished patients are at a higher risk for urinary infection. Additionally, longer durations of using Foley catheters increase the risk of urinary tract infection (Tasota et al., 1998). Therefore, the observed differences may be accounted for by illness of ICU patients, contamination of hands of the personnel during catheterization, or longer use of Foley catheters in the ICU compared to the general wards. In the general wards, the most frequent clinical specimen was urine sample; a finding consistent with previous studies, which indicate urinary infection to be responsible for more than 40% of nosocomial infections (Bruminhent et al., 2010; Pai et al., 2010).

The results of the antibiograms in our study indicated that the antibiotic resistance of bacteria in the ICU is significantly higher, compared to bacteria of the general wards. However, in the case of Cefotaxime, Ceftriaxone, erythromycin and Doxycycline, although resistance was higher in the ICU compared to general wards, their difference did not achieve the level of significance. This finding is in line with previous studies which suggest greater resistance for bacteria of the ICU compared to general wards (Streite et al., 2004; Fridkin et al., 2001). Previous studies have mixed results concerning the resistance and sensitivity of different bacteria in the ICU and general wards. For instance, our study observed *E. coli* to have the greatest sensitivity to Nitrofurantoin (80.2%) in the general wards, whereas a study in Nepal reported *E. coli* to be most sensitive to Amikacin (98%) (Das et al., 2006). Furthermore, our study indicated *Klebsiella* to be most resistant to Cephalexin and Ceftriaxone, and most sensitive to Amikacin (36.9%) in the ICU, while another study reported *Klebsiella* to be most resistant to Gentamicin and Amikacin, and most sensitive to Doxycycline (Ghaznavi-Rad et al., 2010). In general, our study indicates that the most efficient antibiotic against Gram positive bacteria (*Streptococcus, S. aureus*, and coagulase negative *Staphylococcus*) in the ICU to be Vancomycin. For Gram negative bacteria such as *E. coli, Klebsiella* and *Pseudomonas*, the most efficient antibiotics are Amikacin and Vancomycin.

The strong points of our study include a high number of specimens and high number of antibiotic discs used for different kinds of Gram positive and negative bacteria. One weak-point of our study is that length of hospital stay has not been considered: length of hospital stay is one of the major factors for occurrence of nosocomial infections and antibiotic resistance (Tasota et al., 1998). In general, our findings indicate that the frequent bacteria in the ICU of our hospital are similar to other Iranian hospitals and also European and American hospitals. Moreover, drug resistance, particularly multidrug resistance, is common among microorganisms of the ICU as well as the general wards. Therefore, we recommend novel, more efficient antibiotics to be used in case of nosocomial infections. Despite the shortcomings, the findings of our study provide precious data for physicians to select the appropriate antibiotic for treating their patients. Furthermore, it underlines the crucial role of infection control strategies in hospitals, abstention from administering excessive antibiotics, efficient isolation of patients, and effective use of laboratory facilities for rapid diagnosis of microorganisms present within each hospital.

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