Research Paper

Volume : 2 | Issue : 12 | December 2013 • ISSN No 2277 - 8179

Antibiotic Prescription Patterns in aAn Intensive Care Unit in the Kingdom of Bahrain: An Observational Prospective Study

Medical Science

KEYWORDS : Antibiotics, Bahrain

Dr. Ahmed Al Ansari	Director of the Training and Education department, Bahrain Defense Force Hospital Off Waly Alahed Avenue, P. O. Box - 28743, West Riffa, Kingdom of Bahrain
Mohammed Azizullah Khan	Chief resident Department of ICU, Bahrain Defense Force Hospital, Off Waly Alahed Avenue, P. O. Box - 28743, West Riffa, Kingdom of Bahrain
Jalal AI Khan	FRCA, Head of ICU, Bahrain Defense Force Hospital, Off Waly Alahed Avenue, P. O. Box - 28743, West Riffa, Kingdom of Bahrain
Mohammed Lamine Hariz	MD, Chief resident Department of ICU, Off Waly Alahed Avenue, P. O. Box - 28743, West Riffa, Kingdom of Bahrain

ABSTRACT

Background: The aims of this study were to investigate the trend of antibiotic use and to determine the average cost of antibiotics prescribed in the intensive care unit (ICU).

Methods: We carried out an observational prospective study at a 10-bed tertiary-level ICU at the Bahraini Defence Force Hospital from February 2013 until June 2013. We focused on the 75 patients who received antibiotics in the ICU. Our analysis calculates the total number of antibiotics, their class, dose, route, and cost, and presents the results through descriptive analysis and chi square techniques.

Results: A total of 97 patients were admitted to the ICU department during the study period. Of those, 75 patients received antibiotics: 49 (65.3%) were medical and 26 (34.7%) were surgical patients. The mean age of all patients was 51.9 years (SD = 20.1), with the mean age of medical patients at 54.6 years (SD = 23.5) compared with mean age of 45.4 years (SD = 17.8) for surgical patients. The average length of the ICU stay was 7.5 days, ranging from a minimum of one day to a maximum of 36 days. Doctors prescribed a total of 27 antibiotics at admission for 75 of the 97 patients, with a mean of 1.59 (SD = 0.85) at the time of admission. Meropenem was the most common antibiotic used in the ICU, with the total dose of 554.5 grams for the group of patients.

Conclusion: Antibiotics are prescribed for most of the patients admitted to the ICU. A careful selection for patients requiring antibiotics on admission to the ICU will dramatically reduce drug expenses and improve antibiotic performance.

Introduction

Antibiotic resistance was recognized by the World Health Organization as a serious phenomenon which has emerged due to the pervasive prescription of antibiotics in practice.[1] Excessive prescription of antibiotics not only increases the burden of antibiotic resistance but also exposes patients to the side effects of these drugs and increases the treatment costs.[2]

Research and evaluation of antibiotic utilization and antibiotics cost plays an important role in identifying the extent, quality, necessity, and outcome of antibiotic use.[3] More specifically, Biswal et al.[4] reported that antibiotic usage accounts for more than 50% of the cost of therapy in ICUs. Roder et al.[5] found the antibiotic consumption in the ICU was ten times greater than the general hospital wards. Furthermore, researchers have reported strong associations between the number of antibiotic uses and mortality. [4]

As a result of increasing antibiotic resistance and with limited availability of antibiotics to treat new forms of organisms,[6] there is an urgent need for immediate surveillance to study the trends of antibiotic use in ICUs and to investigate the factors that may influence the pattern of antibiotic prescriptions by healthcare professions in ICUs. This form of survey may lead to implementing new policies and procedures, addressing new roles to overcome the inappropriate uses of antibiotics in ICUs. Moreover, calculating the cost of antibiotics prescribed among patients admitted to the ICU might be mandatory for future policies and procedures regarding antibiotic use in ICUs.

There is not much data available on the extent to which the use of antibiotics is appropriate and evidence based in the Bahrain Defence Force Hospital, especially in the ICU. The aim of the present study therefore was to investigate the trends of antibiotic use and to determine the cost of antibiotics prescribed in the ICU at this hospital.

Methods

Design and setting

We carried out an observational prospective study in a 10-bed tertiary-level ICU department at the Bahrain Defence Force Hospital, a 600-bed facility. This is a closed ICU that has 10 active beds and receives critically ill medical, surgical, pediatric, and trauma patients who require hemodynamic monitoring and/or mechanical ventilation. The ICU is managed by specialized consultant anesthesiologists.

We recorded participant data on 75 consecutive patients requiring antibiotics in the ICU between from February 2013 until June 2013. All patients receiving antibiotics in the ICU were included in this study. All antibiotics prescriptions were written either by the primary admitting physician/surgeon, the specialist consultant anesthesiologists in the ICU, or by the infectious disease consultant. There was no policy in place for antibiotic prescriptions for the ICU at this hospital during the study.

We recorded demographic variables on all patients, including patient hospital number, age, gender, comorbidities, clinical diagnosis, length of ICU stay, and (Acute Physiology and Chronic Health Evaluation (APACHE II) score. The main investigator monitored other variables such as number of antibiotics prescribed, date of prescription, dose, duration, route of administration, drug cost, and cultures through a specific chart which we designed for this study using Microsoft Excel 2007. The laboratory performed microbiological analyses of samples collected for cultures based on clinical indications according to standard microbiological methods. Culture site, including tracheal aspiration, blood, urine, CSF, and dialysis catheter, varied according to each specific case.

This study was approved by the ethics committee at the Bahrain Defence Force Hospital. We obtained oral and signed consent either from the patients or the patients' family members. We kept all patients' names and all the collected data confidential and used them for research purposes only.

As noted above, we used Microsoft Excel 2007 for daily data entry. We then used SPSS version 18 for data analysis. We used

descriptive analysis for the majority of the data and chi square techniques to present the results. We considered a *p* value less than 0.05 the cutoff for statistical significance.

Results

A total of 97 patients were admitted to the ICU department during the study period, and of those, 75 patients who required antibiotics were included in this study. Of these 75 patients, 49 (65.3%) were medical and 26 (34.7%) were surgical patients. This included 43 male and 32 female patients. The majority of our patients (40 patients, or 53.3%) were admitted to the ICU from the wards, and the most common diagnosis at admission was chest infection (26 patients, 34.6%). The remaining 35 patients (46.7%) were admitted directly from the emergency room.

The mean age of all patients was 51.9 years (SD = 20.1), with the mean age of medical patients at 54.6 years (SD = 23.5), compared with the mean age of 45.4 years (SD = 17.8) for surgical patients. The average length of the ICU stay was 7.5 days, ranging from a minimum of 1 day to a maximum of 36 days. Medical patients spent an average of 10.2 days in the ICU, while the surgical patients stayed in ICU for an average of 3.5 days. A total of 54 patients were on ventilators during the ICU stay. Of the ventilated patients, 39 were medical cases and 15 were surgical cases.

Insert Table 1 about Here

Doctors prescribed a total of 27 antibiotics at admission for these 75 patients, with the mean of 1.59 (SD = 0.85) at the time of admission. Meropenem was the most common antibiotic used in the ICU. It was prescribed to 39 patients, 24 of them prescribed on the initial day of admission, and 15 patients received Meropenem on the subsequent day. The total use of Meropenem was 554.5 grams for the group of patients.

The number of antibiotics used for each patient on the day of admission to the ICU varied according to the diagnosis. Out of the 75 patients, 26 were on one antibiotic only, but the majority (36) patients were on two antibiotics. Five patients required 3 antibiotics and only 2 required 4 antibiotics. The remaining 7 patients started the antibiotic on the second day of the admission. The total cost for the Meropenem was 5,659 Bahraini dinar (BD), which is equivalent to $15,500.

The other five most frequently used antibiotics in the ICU were as follows: Flagyl (20 patients), erythromycin (20 patients), Rocephine (19 patients), Tazocin (18 patients), and ciprofloxacin for (18 patients). Older patients required higher numbers of antibiotics in comparison with patients less than 45 years old ($p = 0.018$). Patients admitted from medical departments required higher numbers of antibiotics compared to those admitted from the surgical department ($p = 0.048$).

We found no association between the number of antibiotics prescribed and the mortality rate ($p = 0.487$). We assumed patients with higher APACHE II scores would require multiple antibiotics. However, we found no relationship between the number of prescribed antibiotics and the APACHE II score ($p = 0.190$).

Insert Table 2 about Here

Hypertension was the most common comorbidity. Among the 75 admitted patients, 32 exhibited hypertension. The other most common comorbidities were diabetes mellitus (26 patients), coronary artery disease (17 patients), and chronic renal failure (11 patients).

The laboratory reported positive cultures for 51 patients. Out of those, 30 patients had positive cultures on the day of admission and 21 patients had positive cultures on the subsequent days. A positive culture from tracheal aspiration was the most common culture site (32 patients).

Insert Table 3 and 4 about Here

Discussion

In this study we recorded the antimicrobial prescription patterns and the cost incurred in a multidisciplinary ICU. A total of 97 patients were admitted during the four month study period and 75 of them were prescribed antibiotics. Thus, 77.3% of our ICU patients were on antibiotics. Data from other studies have shown that about 60-75% of ICU patients are prescribed antibiotics.[9,10,11] A major chunk of our admissions were due to respiratory infections, followed by sepsis and septic shock due to various infections, post-operative surgical patients, and polytrauma.

Most of the patients admitted from the floors were already on antibiotics, which the ICU doctors adjusted if necessary according to culture and sensitivity. For the patients admitted from the emergency department, the doctors prescribed them antibiotics after obtaining culture specimens, empirically if the doctors suspected an infection; the doctors then adjusted these prescriptions subsequently according to the culture results. The doctors put critically ill patients, especially those in severe sepsis or septic shock, on broad-spectrum antibiotics which they adjusted and, if possible, deescalated as soon as culture results were available, thereby reducing the unnecessary use of broad-spectrum antibiotics.

The laboratory reported positive cultures for 51 patients, 30 of them on admission and 21 on subsequent sampling. Most of the positive cultures were from respiratory secretions, followed by blood and peritoneal fluid. The majority of the positive cultures were *Candida* and most of them from the respiratory tract; however the doctors did not treated all of these, as *Candida* in hospitalized patients from sputum or tracheal aspirate is usually colonization.[12,13] The doctors prescribed anti-fungal medications for patients who grew *Candida* from bronchial lavage and other sites (blood or peritoneal fluid). The other common organisms isolated were *Pseudomonas aeruginosa*, *E. coli* and *Staphylococcus aureus*. A few of our patients had coagulase-negative *Staphylococci*, which did not require any antibiotics because they did not have any signs of bacteremia and the positive cultures were most likely due to contamination from skin. Coagulase-negative *Staphylococci* are part of the normal skin flora, are the most frequent blood culture isolates, and are predominantly culture contaminants.[14,15]

The average length of stay in this study was 7.5 days (medical 10.2 days, surgical 3.5 days), which is slightly higher than this hospital's usual annual stay; this may be a distortion due to the short study period of 4 months. The mortality rate during this period was 18.5%, which is also slightly higher than the hospital's usual annual mortality rate, and also probably due to the short study period.

Meropenem was the most prescribed antibiotic, followed by ceftriaxone, erythromycin, Tazocin, ciprofloxacin and metronidazole. Doctors prescribed erythromycin and ciprofloxacin for the majority of respiratory infections of community-acquired pneumonia, along with another antibiotic. The prescriptions for metronidazole were mostly for abdominal surgeries. The total expenditure on antibiotics for the study period was 14,455 B.D. ($40,000). The cost of Meropenem was 5,659 B.D. ($15,500), which accounted for more than 35% of the total antibiotic cost. Doctors prescribed antifungals (anidulafungin and voriconazole) only for a limited number of patients with fungemia, but their total cost was high because these drugs are very expensive. Other antibiotics adding significantly to the antibiotic cost were Tazocin, linezolid, erythromycin, and ceftizidime.

The doctors in the ICU prescribed antibiotics according to sensitivity. When the doctors prescribed the medicines empirically, they adjusted and de-escalated them as soon as feasible. Nevertheless, some antibiotics, especially Meropenem, were overused. The ICU is now in the process of implementing strict antibiotic prescription guidelines to limit over-prescription of particular antibiotics and also to adapt a policy of antibiotic rotation. This should allow more efficacious use of the available antibiotics and possibly cut costs without compromising patient care. Rotation or cycling is a well-known method used to prevent the

Volume : 2 | Issue : 12 | December 2013 • ISSN No 2277 - 8179

emergence of resistant organisms; its use may therefore prove beneficial for both the patients and the hospital.[16,17]

DEMOGRAPHIC DATA				
	N	Medical	Surgical	P. Value
NUMBER OF ADMISSIONS DURING STUDY PERIOD	97	60	37	
NUMBER OF PATIENTS ON ANTIBIOTICS	75	49	26	
MALE	43	25	18	
FEMALE	32	24	8	
AGE (average)	51.9 SD=20.1	54.6 SD=23.5	45.4 SD=17.8	0.018
ADMITTED FROM E.R	35(46.6%)	24	11	
ADMITTED FROM WARDS	40(53.3%)	25	15	0.048
VENTILATED AT ANY TIME	54	39	15	
LENGTH OF I.C.U. STAY	7.5 days	10.2 days	3.5 days	0.001
APACHE	25.055	29.16	19.41	0.190
PREDICTED MORTALITY	46.61	56.12	24.86	
ACTUAL MORTALITY	18.5%	23.33%	10.81%	0.487

Table II

ANTIBIOTICS AND COST					
ANTIBIOTIC	N	PRESCRIBED ON Initial Days	PRESCRIBED ON Subsequent Days	TOTAL DOSE COST	
ZINACEF (CEFUROXIME)	12	12	0	48. 750 GRAMS	41
ROCEPHIN (CEFTRIAXONE	19	18	1	131 GRAMS	275
TAZOCIN (PIPRACILLIN+	18	9	9	1048. 5 GRAMS	1191
TAZOBACTUM)					
MEROPENEM	39	24	15	554. 5 GRAMS	5659
FORTUM (CEFTIZIDIME)	12	4	8	141 GRAMS	463
FLAGYL (METRINIDOZOLE)	20	14	6	196 GRAMS	142
ERYTHROMYCIN	20	12	8	168 GRAMS	470
CIPROFLOXACIN	18	10	8	50. 4 GRAMS	160
CLARYTHROMYCIN	4	4	0	8 GRAMS	43
AZTREONAM	1	0	1	20 GRAMS	70
SEPTRIN (TRIMITHOPRIN +	1	0	1	8. 640 GRAMS	5
SULPHAMETHAXOLE)					
COLISTIN (COLOMYCIN)	2	0	2	44 MILLION I.U	62
CLINDAMYCIN	3	2	1	45. 450 GRAMS	113
MOXIFLOXACIN	1	1	0	0. 8 GRAMS	5
LEVOFLOXACIN	2	0	2	9. 7 GRAMS	2 03
TAMIFLU (OSILTAMIVIR)	5	5	0	2.550 GRAMS	15
GENTAMYCIN	2	0	2	0. 9 GRAMS	6
CEFAZOLIN	1	1	0	1 GRAM	0,5
TIGECYCLINE	1	0	1	0. 5 GRAMS	210
VORICONAZOLE	1	0	1	8. 3 GRAMS	1597
VANCOMYCIN	11	2	9	32. 5 GRAMS	53
AMIKACIN	5	0	5	40 GRAMS	131
FLUCONAZOLE	6	1	5	7.650 GRAMS	555
ANIDUL OFUNGIN	4	0	4	2. 850 GRAMS	2280
LINEZOLID	3	0	3	13. 8GRAMS	706
TOTAL COST					14455 B.D

Table III

ADMITTING DIAGNOSIS	
DIAGNOSIS	N
CHEST INFECTION	26
COPD ACUTE EXACERBATION	2
UROSEPSIS	3
SEPTIC SHOCK	9
POST CARDIAC ARREST	3
GASTROINTESTINAL BLEED	1
PUPERIAL SEPSIS	1
SICKLE CELL DISEASE WITH ACUTE CHEST SYNDROME	1
DROWNING	1
STATUS EPILEPTICUS	2
INTRACEREBRAL HAEMORRHAGE	2
ABDOMINAL AORTIC ANEUTYSM REPAIR	1
POST OPERATIVE LAPAROTOMY/LAPAROSCOPY	10
POST CRANIOTOMY FOR BRAIN TUMOR	3

Table IV

POSITIVE CULTURES			
CULTURE SITE	N	ON ADMISION	ON SUBSEQUENT DAYS
POSITIVE CULTURES	51	30	21
TRACHEAL ASPIRATE/BAL	32	19	13
BLOOD	5	3	2
URINE	3	3	0
PERETONIAL FLUID	4	2	2
STOOL	1	1	0
CSF	2	1	1
SCALP WOUND	1	0	1
TRACHEOSTOMY SITE SWAB	1	0	1
DIALYSIS CATHETER	1	0	1

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