Microbial pattern and antibiotic resistance in Ardabil city hospitals

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Abstract

Introduction: Antibiotic arbitrary use by increasing resistance changed to a growing issue in the 21st century and its optimal use in hospital could be essential for reducing health system costs and drug side effects.
Objectives: The aim of this study was to investigate the pattern of antibiotic use in prescribed prescription.
Patients and Methods: This was a cross-sectional study that has been done on 300 prescriptions which selected randomly form Ardabil city hospitals. The anatomical therapeutic chemical classification system with defined daily doses (ATC/DDD) standard measurement method recommended by World Health Organization (WHO) was conducted in the study. The amount uses rate of each medication calculated by DDD/100 bed days. Data collected by a checklist and analyzed by statistical methods in SPSS version 21.
Results: The highest prescribed antibiotic was ciprofloxacin with 32% and the total antibiotics uses rate during study period was 44/95 DDD/100 Bed days. The mean number of drugs and prescribed antibiotics in intensive care unit (ICU) ward was more than other wards. However, comparing the rate of antibiotics use between wards based on ATC/DDD method showed that the infection ward with 62.9 was more than other wards. The most form of used antibiotics with 69% was in the form of Ampule and in intravenously method with 64% in all wards.
Conclusion: The results of this study showed that the most used antibiotics by considering the studied method, prescribed dose and the hospitalized days were in internal and surgery ward respectively but according ATC/DDD method the most used antibiotics was in infection ward.

Introduction

Antibiotics are products that naturally produced by microorganisms or artificially and deal to kill or inhibit the growth of microorganisms. According to the World Health Organization (WHO), antibiotic resistance is one of the consequences of improper use of antibiotic treatments and occurs when a microorganism are mutated or take the gene for resistance from another bacterium (1). In hospitals, antibiotics are one of the most widely used prescribed drugs for patients and antibiotic resistance of microbes and the infections caused by these bacteria, have always been a major problem in the treatment of nosocomial infections (2-4). Statistical studies show that 30%-50% of patients receive antibiotic therapy during their hospitalization that about half of which is unnecessary (5,6). About 5-15% of patients become infected during hospitalization, which is 1-5 times more common in patients

Key point

This hospital based study on prescribed medication in various sections of a central hospital in Ardabil city can be used in control of Antibiotic arbitrary use by using a standard anatomical therapeutic chemical classification system with defined daily doses (ATC/ DDD) method and in future deal to decreasing this rate among patients. The result of this study can be used in health policy of each hospital and decreasing health costs and burden diseases.

admitted to the intensive care unit (ICU) (7,8). The United State Centers for Disease Control and Prevention estimated that about 50 million of the 150 million yearly prescribed prescriptions for patients are unnecessary. Some studies showed that, some parts of hospitals are less likely to be affected by multidrug resistant organisms due to using less antibiotics (9-11). Infections caused by resistant bacteria are dangerous which require long term treatment and more

hospitalization time with high complications and costs. In many times, diagnosis and treat of patients was difficult and can increase mortality rate (12,13). Study the using pattern of prescribed antibiotics and their monitoring could be one of the factors that influencing the rationale use of prescribed antibiotics and reducing their overuse. Today, production of new drugs by the health system need for a lot of time, money and manpower, so we should more attention to the rights about the method of using existing drugs and their benefits to reduce the problems caused by their misuse. Awareness about the consumption pattern of prescribed antibiotics and their current status in each hospital can be essential for adopting antibiotic consumption strategy (14). Due to the high costs imposed on health systems to reduce the effectiveness of antibiotics and on the other hand, due to the increasing microbial resistance in many countries with high uses rate of antibiotics, the need for effective policies to control the overuse of antibiotics around the world is essential (15,16).

Objectives
The aim of this study was to investigate the pattern of antibiotic use in different wards of Ardabil city hospital.

Patients and Methods
Study design
This cross-sectional study was performed on 300 prescribed prescriptions for patients admitted to the infectious, internal, surgical and ICU, wards of Ardabil city hospitals during year of 2019. In this study, we used the anatomical therapeutic chemical classification system with defined daily doses (ATC/DDD) proposed method by WHO to evaluate the pattern of used drugs by patients. The required data were collected through a checklist containing demographic and clinical information of patients including age, gender, drug name, drug form and dose of used drugs. The unit (DDD / 100 bed-days) which indicates the amount of DDD per used drugs per 100 occupancy rate beds per day is used to measure the dose of medication in hospitals and calculated as follows:

DDD/1000 inhabitants/day

$$= \frac{\text{Antibiotic Consumption (DDD)} \times 100}{\text{Number of Beds} \times \text{Occupancy} \times \text{Study period (day)}}$$

In this study, all drug groups including anti systemic infective drugs, systemic antibacterial, systemic antimycotic, systemic anti tuberculosis and systemic antiviral were examined.

Statistical analysis
We used one-way ANOVA for comparing means between drugs. The collected data were analyzed using descriptive and analytical statistical methods in SPSS version 21. P value less than 0.05 was considered as significant.

Results
The present study showed that 58% of prescriptions were for male patients and the rest for female patients. Of all patients, 31% had over 60 years age. The average number of prescribed drugs and the average number of prescribed antibiotics in the ICU ward was significantly higher than other wards (Table 1).

The most commonly prescribed antibiotic was ciprofloxacin with 32% that 64% was used in the ICU and 40% was used in the internal ward. Most of the prescribed antibiotics in the ICU ward were meropenem and ciprofloxacin with 72% and 64% respectively, in the infectious ward was clindamycin with 24%, in the internal ward was ciprofloxacin with 40% and in the surgery ward was cefazolin with 44% (Table 2).

The highest class of prescribed antibiotics were fluoroquinolones with 35%, carbapenem with 31% and macrolides with 28%. In the ICU ward, carbapenem and fluoroquinolones with 76%, in the infectious ward macrolides with 24%, in the internal ward fluoroquinolones with 40% and in the surgery ward, cephalosporin class 1 with 44% were the most prescribed antibiotic classes (Table 3). The highest pharmacological form of prescribed antibiotics with 69% was in the form of ampoules and intravenously with 64% in all wards (Table 4). The using rate of antibiotic in the infectious ward with 27.6% was higher than other wards but statistically the difference between the wards was not significant (Figure 1). The total daily dose of antibiotics at 100 occupation beds was 45.99 DDD/100 bed days that most of which ciprofloxacin with 88 score in the infection ward, 48 in the ICU ward and the internal ward Clindamycin with a score of 79 and in the surgical ward Ceftriaxone with a score of 94. However a comparison of used antibiotic between different wards based on the ATC/DDD method showed that the internal ward had the highest antibiotic uses rate with 75.64 (Figure 2).

Discussion
The present study was the first report on the administration of antibiotics in Ardabil hospitals which showed that the highest prescribed antibiotic during three months was ciprofloxacin with 32% and the total rate of used antibiotic during three months was 45.99 DDD/100 bed days that

Table 1. Mean of used drugs indexes by ward

Indexes	Ward	Mean	SD	*P* value
Prescribed drugs	ICU	19.4	9.2	0.001
	Infection	5.7	3.6	
	Internal	11.2	5.2	
	Surgery	5.7	3.9	
Prescribed antibiotics	ICU	4.7	2.9	0.001
	Infection	1.5	1.5	
	Internal	1.6	1.4	
	Surgery	1.4	1	

Table 2. The frequency of 10 prevalent used antibiotics by ward

Ward antibiotics	ICU		Infection		Internal		Surgery		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Cefazolin	9	12	9	12	-	-	33	44	51	17
Ceftriaxone	33	44	15	20	18	24	3	4	72	24
Meropenem	54	72	3	4	18	24	3	4	78	26
Clindamycin	21	28	18	24	15	20	-	-	54	18
Metronidazole	18	24	9	12	12	16	6	8	45	15
Ciprofloxacin	48	64	15	20	30	40	3	4	96	32
Levofloxacin	27	36	-	-	3	4	-	-	30	10
Targocid	21	28	-	-	3	4	-	-	24	8
Tazocin	21	28	-	-	-	-	-	-	21	7
Vancomycin	33	44	-	-	15	20	-	-	48	16

Table 3. The frequency of used antibiotics classes by ward

Ward classes	ICU		Infection		Internal		Surgery		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Carbapenem	57	76	12	16	21	28	3	4	93	31
3rd Generation, cephalosporin	36	48	15	20	15	20	9	12	75	24
Beta-lactam	18	24	12	16	3	4	-	-	33	11
1st generation, cephalosporin	6	8	12	16	-	-	33	44	51	17
Nitroimidazole	15	20	6	8	12	16	6	8	39	13
Fluocinolon	57	76	15	20	30	40	3	4	105	35
Macrolides	42	56	18	24	18	24	6	8	84	28
Aminoglycosides	9	12	12	16	-	-	-	-	21	7
Sulfonamides	6	8	-	-	-	-	-	-	6	2
Glycopeptide	24	32	-	-	15	20	-	-	39	13
Penicillin	-	-	-	-	-	-	15	20	15	5
Polymyxin	3	4	-	-	-	-	-	-	3	1
Tetracycline	3	4	-	-	-	-	-	-	3	1

Table 4. The frequency of form and method of prescription of used antibiotics by ward

Wards		ICU		Infection		Internal		Surgery		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%
Form of used drugs	Ampoule	69	92	42	56	42	56	54	72	207	69
	Capsule	9	12	-	-	-	-	3	4	12	4
	Tablet	21	28	12	16	6	8	3	4	42	14
	Drop	-	-	-	-	3	4	-	-	3	1
	Oint	-	-	3	4	-	-	-	-	3	1
Method of prescription	Intravenous injection	66	88	36	48	45	60	45	60	192	64
	Intramuscular injection	3	4	3	4	-	-	-	-	6	2
	Orally	30	40	6	8	3	4	6	8	45	15
	Topical	-	-	3	4	-	-	-	-	3	1
	Drop	-	-	-	-	6	8	-	-	6	2

of which, ciprofloxacin in the infection ward with a score of 88, ciprofloxacin in the ICU with a score of 48, in the internal ward clindamycin with a score of 79 and in the surgery ward was ceftriaxone with score 94.

A study in Germany found that the average antibiotic use in the ICU of all German university hospitals was 140, which was higher than the present study results (17).

In the study conducted by Hajebi et al, the total amount of consumed antibiotics during the study period in the hospital was 99.83 DDD/100 Bed days which was much higher than the present study with 45.9 (15).

Noubarani et al, in a study showed that the total consumption of antibiotics in the hospital during the study period was 79.79 DDD/100 bed days which was the highest
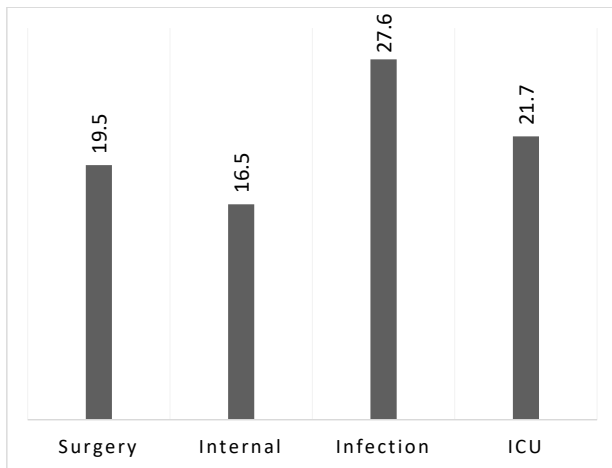
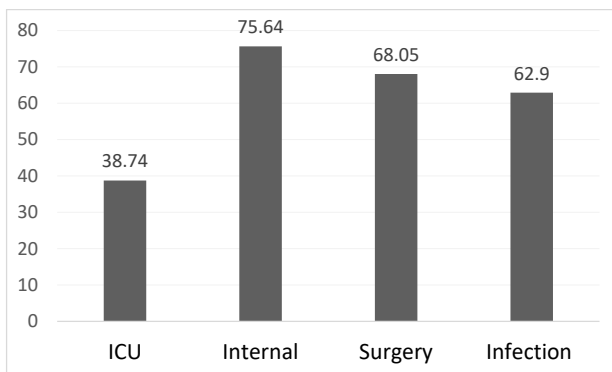**Figure 1**. Frequency of prescribed antibiotics by wards

Figure 2. Frequency of uses rate of prescribed antibiotics based ATC/DDD method by wards

rate of infection (27%). Cephalosporin have the highest consumption in most parts with an average consumption of 48.5%. The total index of antibiotic use in the present study was lower and cephalosporin had the highest average consumption rate in the infection ward which was similar to the above study (18). Of course, high consumption of these drugs can depend on the range of broad – spectrum effects of prescribed drugs. In the present study, the increase in consumption of cephalosporins, 3rd generation compared to studies conducted in European hospitals could be due to the policy of imposing restrictions on the administration of cephalosporins, 3rd generation in hospitals (19,20).

Antibiotic use pattern can be varied between hospitals in a country, which can be due to national and international differences in antibiotic use, differences in demographic characteristics, differences in the health system managements and physicians' preferences in prescribing, the price of antibiotics, the access rate to antibiotics, drug resistance, prevalence and severity of diseases. The difference in the group of high-consumption antibiotics in this study with other external studies also confirms

this while in foreign studies the group of penicillins had the highest consumption, in this study fluoroquinolones and then carbapenem had the highest consumption rates (4). In the present study in the ICU ward, carbapenem and fluoroquinolones with 76% and in the internal ward carbapenems with 28% were the most prescribed antibiotics classes. Carbapenem consumption in the ICU ward of a hospital in Italy was 7.1 times higher than internal ward and in a hospital in France was 17.5 times higher than internal ward (21). In another external study, higher rate of using carbapenem in the ICU than in the internal ward may be due to the higher prevalence of resistant infections in this ward or due to stricter policies regarding the restriction of the use of this drug in the internal ward compared to the ICU ward. According to Guideline of National Health Service, meropenem is a restricted drug which used in the exception of the ICU prescribed only after confirmation of microbial culture and consultation with a microbiologist, because patients hospitalized in the ICU are more susceptible to resistant infections due to their vulnerability as well as the high volume of invasive processes (22). The high prevalence of carbapenem use in the present study can be attributed to the higher prevalence of resistant infections or to its indiscriminate prescription by physicians. In a study conducted by the study of Mohammadi et al at the ICU of Mashhad hospital, the results showed that the administration of vancomycin at 68% and the start of carbapenem at 48% of cases were irrational (23). In another study conducted at four different NICUs in New York, the results showed that the prescription of vancomycin in 32% and carbapenems in 43% of patients was irrational (24). In this study, the most common form of used antibiotics was intravenously and by injection. In line with our study, at the study of Ebrahimzadeh et al in Sari, the injectable form of antibiotics was the most common method of prescription (25). In this study, the ranking of the wards was different using two study methods. The reason for this difference was due to the different used antibiotics in each ward with different doses and the number of days the medication was taken. In fact, comparing DDD/100 Bed days indexes between the same wards of different hospitals and also at different time intervals should be done to measure the amount of used antibiotics in different hospitals and over time by repeating the study, the effectiveness of antibiotics and the possibility of antibiotic resistance in hospitals in Ardabil will be available. The result of this study was ethically approved by Ardabil university ethical committee.

Conclusion
In general, the high consumption of carbapenems, macrolides and cephalosporins, 3rd generation in Ardabil hospital is worrying both due to the higher prevalence of resistant infections and due to its irregular prescription by a physician. In either case, the cause for this problem must be identified and action must be taken to reduce the factors

involved. These pharmaceutical categories are considered as the last line of treatment in many guidelines and in many hospitals they are prescribed under the supervision of the Infectious Diseases Control Committee and in case of resistance to other drugs. The results of this study could be helpful at future in designing health interventions and health policies to improve the quality of antibiotic prescribing and having the right pattern of antibiotic use.

Limitations of the study

In term of limitation, we have some limitation: since this study quantitatively examines the pattern of antibiotic use and despite the high rate of antibiotic use in Ardabil hospitals compared to similar studies it is not possible to say whether this volume of consumption was reasonable or not. Furthermore in this study we have not have information about the result of antibiotic resistance, type of infection and organism, so we cannot discuss about this issue in our study and compare our results by other studies.

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