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RESEARCH ARTICLE **OPEN ACCESS**

Determining the Type and Frequency of Prescribed Antibiotics in Patients Admitted to the Infectious Department of Imam Khomeini Hospital in Jiroft, year 2021 (A Cross-Sectional Study)

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Abstract:

Background: Indiscriminate administration of antibiotics and excessive use of these drugs increase microbial resistance.

Aim: This study aims to investigate the type and frequency of prescribed antibiotics in patients admitted to Imam Khomeini Hospital in Jiroft in 2021.

Methods: In this cross-sectional study, the files of 5100 patients hospitalized in the infectious disease department of Imam Khomeini Hospital in Jiroft were examined. The criteria for inclusion in the study were patients admitted to the infectious disease department of Imam Khomeini Hospital for whom antibiotics were prescribed in the treatment order. The data was collected through a checklist that included demographic information, type of antibiotic used, prescribed dose, season of prescribing, and expertise of the prescriber. Data were analyzed with SPSS software.

Results: The results of the study revealed that the average number of antibiotic items consumed per person in the infectious department of Imam Khomeini Hospital in Jiroft City was 1.95 ± 0.4. Also, the most common antibiotic used in the present study was ceftriaxone, which accounted for more than 70% of the total prescribed antibiotics, and the highest average number of antibiotic items studied per prescription was related to vancomycin. In addition, the highest frequency of prescribed antibiotics was related to the autumn season and was prescribed by an internist.

Conclusion: In this study, ceftriaxone is the most widely used antibiotic in the infectious sector. Also, the highest frequency of prescribed antibiotics was related to the autumn season and prescribed by an internist.

Keywords: Prescribed, Antibiotics, Patient, Infectious department, Hospital, Infectious sector.

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1. INTRODUCTION

Infectious diseases have been a major concern for human health throughout history, posing significant threats to populations all around the world [1, 2]. From devastating pandemics like the Black Death in the Middle Ages to more recent outbreaks such as Ebola and Zika, these diseases have constantly challenged our ability to control and contain them [3, 4]. Factors like increased global travel, urbanization, and climate change facilitate the spread of infectious diseases. Additionally, mutations and resistance development in pathogens further complicate efforts to combat these illnesses [5, 6].

While advancements in medical research and technology have led to improved treatments and preventive measures, the ongoing threat of emerging infectious diseases highlights the need for continued vigilance and investment in public health efforts globally [7, 8]. Infectious diseases have threatened human health for a long time. A wide range of drugs have been developed to fight infectious diseases [9-11].

Antibiotics are one of the largest groups of drugs developed to fight and prevent the spread of infectious diseases. An antibiotic is a substance that is prepared from a microorganism and causes the destruction or prevention of the growth of another microorganism [12, 13].

Antibiotics are a crucial component of modern medicine, serving as one of the most significant groups of drugs developed to combat infectious diseases [14]. These powerful medications work by either killing or inhibiting the growth of bacteria, effectively treating a wide range of infections [15, 16]. Since their discovery in the early 20th century, antibiotics have revolutionized medical practice and saved countless lives. However, misuse and overuse of antibiotics have led to the emergence of antibiotic-resistant strains of bacteria, posing a grave threat to public health [17, 18].

It is essential for healthcare professionals to prescribe antibiotics judiciously and for patients to follow proper dosing instructions to help preserve the effectiveness of these life-saving medications for future generations [19]. Antimicrobial stewardship programs are being implemented worldwide to promote responsible antibiotic use and combat antibiotic resistance, ensuring that these vital drugs remain effective in fighting infectious diseases both now and in the future [20, 21].

Antibiotics have the ability to destroy microorganisms with cellular structures, such as bacteria, and have no effect on viruses. Antibiotics in therapeutic doses are almost harmless to the host body, so they can be easily used to treat bacterial infections [22]. Antibiotics differ in their effectiveness against different types of bacteria. This efficiency can be different according to the site of infection, the ability of the antibiotic to reach the site of infection, and the ability of bacteria to resist or deactivate the antibiotic. Some antibiotics, also called bactericides, can kill bacteria, while others, called bacteriostatic or "bacteriostatic," only stop the bacteria from multiplying so that the host's immune system can attack to overcome them [23-25].

Oral antibiotics, if effective, are considered the easiest way to kill bacteria, and intravenous antibiotics are used for acute infections. Antibiotics may sometimes be made and used topically, such as eye drops or ointments [26]. Using antibiotics in inappropriate conditions is another common way of abusing them. Common examples of this are the use of antibacterials for viral infections such as colds [27, 28].

Despite the fact that prescribing antibiotics is necessary in most bacterial infections and not taking them threatens the patient's life, most studies have shown that 30 - 60 percent of prescriptions were incorrect and inappropriate, and usually, these mistakes are made by doctors, distributors or Self-treatment has taken place [29, 30]. From an economic point of view, the cost of antibiotic treatment in 2000 was estimated at 40 billion dollars, of which the share of developing countries was about one-third. In 1990, the percentage of antibiotic sales of all medicines worldwide was 12%, of which the share of developing countries was 19%, while in 2000, this figure reached 34%. Therefore, the growth of the cost of antibiotics, especially in developing countries, has continued despite the efforts made to limit the unnecessary use of antibiotics [31-33].

Antibiotic resistance is a pressing issue that has garnered increasing attention on a global scale [34]. The proliferation of antibiotic-resistant bacteria poses a significant threat to public health, as it diminishes the effectiveness of antibiotics in treating bacterial infections. This phenomenon has been exacerbated by the overuse and misuse of antibiotics in human and animal healthcare, as well as in agriculture [35, 36]. Antibiotic resistance

requires a multifaceted approach to address, encompassing improved infection prevention and control measures, prudent use of existing antibiotics, development of new antibiotics, and enhanced surveillance and monitoring systems [21]. Failure to effectively combat antibiotic resistance not only jeopardizes the efficacy of current medical treatments but also has far-reaching implications for society at large, including increased mortality rates, prolonged illness durations, and higher healthcare costs. Stakeholders from various sectors must collaborate and prioritize this issue to safeguard public health now and for future generations [37].

Antibiotic resistance is a growing concern globally, with the overuse and misuse of antibiotics leading to an increase in resistant bacteria [38, 39]. In Iran specifically, antibiotic resistance rates have been on the rise due to factors such as inadequate infection control measures in healthcare facilities, widespread self-medication practices among the population, and easy availability of antibiotics without a prescription [40, 41]. The prevalence of drug-resistant infections poses a significant threat to public health in Iran, as it limits the effectiveness of commonly used antibiotics and complicates treatment regimens for bacterial infections. To combat this issue, increased surveillance efforts, better regulation of antibiotic use, and enhanced education programs for healthcare professionals and the general public are urgently needed to preserve the effectiveness of existing antibiotics and prevent further escalation of antibiotic resistance in Iran [42-44].

The increase in resistant species and the decrease in the efficiency of antibiotics have also caused huge costs to the health system. Since the highest incidence of resistance has occurred in the countries that have had the highest consumption, the use of antibiotics is necessary worldwide, and it is necessary to implement new and more effective policies to control consumption [45, 46]. Considering the necessity and importance of the material presented in the introduction section and the fact that a wide range of antibiotics is used to treat hospitalized patients in the infectious department, the present study aims to determine the type and frequency of antibiotics prescribed in hospitalized patients. It was conductedin the infectious department of Imam Khomeini Hospital in Jiroft in 2021.

2. MATERIALS AND METHODS

This study was conducted in a retrospective cross-sectional manner. In this research, the information contained in the patients' files was used to collect information. The criteria for inclusion in the research were the files of patients admitted to the infectious department of Imam Khomeini Hospital who were prescribed antibiotics in the treatment order, and the criteria for exclusion from the research included files with incomplete information. The researcher referred to the medical records unit of the hospital, extracted the necessary information from the patient’s files, and added it to the researcher's checklist. Characteristics of the data collection tool included collecting information through a checklist that includes two parts: demographic information (age and sex) and the reason for hospitalization, the type of antibiotic prescribed, the number of times prescribed, the prescribed dose, the season of prescribing, and the specialty of the prescriber. Data analysis was performedusing SPSS version 20 statistical software. Mean and standard deviation were used to describe quantitative variables, and frequency (the kind of antibiotics) and percentage were used for qualitative data (age, sex, and hospitalization period (days)). For qualitative variables, the Chi-score compares the proportion of prescribed antibiotics in different seasons and the expertise of a doctor who prescribes internal antibiotics. The significant level for all tests was considered less than 0.05.

In order to comply with ethical considerations in this research, the information of the participants was kept confidential, and other people were not able to access it. The names and surnames of the participants were not used for data collection, and data was collectedafter obtaining the code of ethics from Jiroft University of Medical Sciences.

3. RESULTS

This is a cross-sectional study of 5100 people who received antibiotics during their hospitalization in the infectious department of Imam Khomeini Jiroft Hospital, and its data was collected and analyzed. Table **1** lists the information related to the demographic variables of the examined patients. Out of 5100 people, 33.3% were women, and 66.7% were men. The average age was 34 ± 22.4 years, the highest and lowest age of the patients was 85 years and 6 years, respectively, and the highest frequency was observed in the age group of 21-40 years. The hospitalization period of most patients was between 1 to 5 days (78.5%).

Table **2** revealsthe information related to the frequency of the studied antibiotics. The results indicate that the order of the highest to the lowest antibiotic frequency is Ceftriaxone (76.7%), Vancomycin (13.5%), Meropenem (6.5%), Imipenem (2.5%), Gentamicin (0.3%) and Amikacin (0.2%).

Table **3** demonstrates the information about the average number of items of the studied antibiotics. The results indicate that the highest average number of items related to vancomycin with a value of 2.4 ± 0.46, and the lowest average number related to ceftriaxone with a value of 1.6 ± 0.34, and in general, the average number of antibiotic items used per patient was 1.95 ± 0.4.

Table 1. Frequency and percentage of demographic variables in the studied patients.

Variable		Frequency	Percentage
Sex	Men	3401	66.7
	Women	1699	33.3
Age	1-20	596	11.7
	21-40	2080	40.8
	41-60	1218	23.9
	61-80	958	18.8
	> 80	248	4.8
Hospitalization period (days)	1–5	4003	78.5
	6-10	856	16.8
	11-15	127	2.5
	16-20	114	2.2

Table 2. Frequency of studied antibiotics.

Variable		Frequency	Percentage
Antibiotics	Amikacin	40	0.2
	Ceftriaxone	11548	76.7
	Gentamicin	59	0.3
	Imipn	381	2.5
	Meropenem	980	6.5
	Vancomycin	2035	13.5
	Total	15043	100

Table 3. The average of the studied antibiotic items.

Variable		Mean	Standard Deviation
Antibiotics	Amikacin	1.9	0.38
	Ceftriaxone	1.6	0.34
	Gentamicin	1.8	0.41
	Imipn	2	0.45
	Meropenem	2.03	0.4
	Vancomycin	2.4	0.46
	Total	1.95	0.4

Table **4** shows the information related to the frequency of prescribing antibiotics by season. The highest frequency of prescribed antibiotics, with 28.1%, is related to the autumn season, and the lowest is 20.1%, related to the summer season. In the number of prescriptions, there was a significant difference in antibiotic drugs in different seasons of the year (P-value=0.05).

Table **5** shows the information related to the frequency of prescribing antibiotics according to the specialty of the prescribing physician. The results indicate that the highest number of antibiotics was prescribed by internists (53.4%), and the lowest number of antibiotics were prescribed by other specialties, including (1.9%) neurology, heart, and rheumatology were prescribed. There was a significant difference between the frequency of prescribing antibiotics (P-value=0.043).

Table 4. Frequency of prescription of antibiotic drugs by season.

Variable		Number	Percent	P-value
Season	Spring	3580	23.7	0.005
	Summer	3024	20.1	
	Fall	4242	28.1	
	Winter	4197	27.9	
The number of prescribed antibiotics		15043	100	

Table 5. The frequency of prescribing antibiotics according to the specialty of the prescribing doctor.

Variable		Number	Percent	P-value
The expertise of a doctor who prescribes internal antibiotics	Internal	8034	53.4	0.043
	Infectious	5612	37.3	
	surgery	1097	7.4	
	Etc	300	1.9	
The number of prescribed antibiotics		15043	100	

4. DISCUSSION

Unnecessary and incorrect use of antibiotics is an important issue all over the world. Despite detailed research on antibiotic prescribing in hospitals around the world, there is not enough information about our country and city. In order to plan and make future policies to reduce or standardize the use of antibiotics, it is necessary to have accurate statistics on antibiotic use. Based on the national action plan of the Islamic Republic of Iran to curb microbial resistance, which was presented in December 2015, rational prescription and use of antimicrobial drugs in inpatient and outpatient departments and promoting the appropriate use of antimicrobial drugs should be monitored [12, 47]. Therefore, the present study was conducted with the aim of determining the type and frequency of antibiotics prescribed to patients admitted to the infectious department of Imam Khomeini Hospital in Jiroft in 2021.

The results of the present study showed that ceftriaxone is the most widely used antibiotic in the infectious sector. This finding is significant as ceftriaxone belongs to the cephalosporin class of antibiotics and is known for its broad-spectrum activity against a wide range of bacteria, making it an effective treatment option for various infections. Its popularity can be attributed to its efficacy in treating severe bacterial infections such as pneumonia, meningitis, sepsis, and urinary tract infections [48, 49]. Additionally, ceftriaxone is often preferred due to its convenient dosing schedule (once daily or twice daily) and favorable safety profile when compared to other antibiotics. As such, these results underscore the importance of ceftriaxone in clinical practice and highlight its widespread use in combating infectious diseases.

In two studies conducted inside the country at Bo Ali Hospital in Tehran and Imam Hospital in Sari, Ceftriaxone, Cefazolin, Vancomycin, Ceftizoxime, and Gentamicin were reported to be the most commonly used antibiotics [50, 51]. In a study conducted in the children's department of Hajar Shahrekord Hospital, ceftriaxone was reported to be the most commonly used antibiotic [52]. Ceftriaxone, an antibiotic of the third generation of cephalosporins, registered among drug side effects in the Center for Registration and Investigation of Unwanted Drug Adverse Reactions (ADR) has received the greatest number of reports. In Nobrani *et al*.'s study, cephalosporins and quinolones were among the most widely used antibiotics in most departments [53]. In the study by Sepehri *et al*. in Kerman, penicillins, cephalosporins, and aminoglycosides were the first priorities for antibiotic prescription [54]. Cephalosporins had the highest amount of consumption in the Turkish study [55] and Hajbi's study in Taleghani Hospital [56], and in Ahmadi's study, 42% of the total antibiotic consumption was related to this group [57]. Ceftriaxone is the drug with the most complications in the reports received by the Center for Registration and Investigation of Adverse Drug Reactions in the country, so among the reports received by the ADR Center until December 2018, Ceftriaxone caused the most complications with 1,715 cases and also recorded 55 deaths. It has also accounted for the highest number of deaths [58]. The reported side effects mainly include skin side effects, digestive side effects, shortness of breath, anaphylactic shock, anaphylactic-like reactions, and cardiac arrest, and in many cases, the reaction was severe and life-threatening [59]. Unfortunately, one of the reasons for the increase in the occurrence of drug side effects with ceftriaxone is the excessive use of this drug in unnecessary cases, such as colds or cases that are not among the approved uses of this product in scientific sources and can be avoided by using other safer products. Another factor that has increased the occurrence of unwanted side effects with ceftriaxone is not checking the history of the patient's allergy to penicillins or other cephalosporins because penicillins and cephalosporins have cross-sensitivity, and people sensitive to penicillins may also be sensitive to cephalosporins, so a person's history of sensitivity to antibiotics should be considered before taking the drug. On the other hand, the non-observance of some points in the injection of this product, such as rapid intravenous injection and injection in centers that lack the facilities and equipment of the resuscitation system, has caused that in case of severe reactions, it is not possible to control and perform appropriate treatment measures.

The highest average of antibiotic items studied in each prescription was related to vancomycin. In the realm of prescription medications, a significant finding has emerged regarding the prevalence of vancomycin in antibiotic prescriptions. This phenomenon can be attributed to several factors, including its broad spectrum of activity against gram-positive bacteria and its efficacy in treating serious infections. Additionally, vancomycin is often chosen as a last-resort treatment option for patients who have developed resistance to other antibiotics. The high average of vancomycin items present in each prescription underscores its importance in modern medicine and highlights the continued need for effective antibiotic stewardship practices to combat antimicrobial resistance.

In Nobrani *et al*.'s study, the average consumption of

vancomycin was between 1.57 and 2.2 [53], and the study was conducted in the infectious department of Imam Hospital, Khomeini, Tehran. Out of 565 patients studied, 39 patients received vancomycin with at least 2 doses per prescription [60]. Probably, most cases of Vancomycin drug use were experimental, and this could be caused by the routine use of the experimental drug and the lack of confidence in the results of the antibiogram. Also, in the study conducted on the similar efficacy of Teicoplanin and Vancomycin in hemodialysis patients, it was found that due to the relatively similar response to treatment and side effects of Teicoplanin and Vancomycin and the higher cost of Teicoplanin in our country, Vancomycin is still used in the treatment of catheter site infection. It is preferable in hemodialysis patients [61].

The average number of antibiotic items used per person in the infectious department of Imam Khomeini Hospital in Jiroft City is 1.95 ± 0.4, which is in line with the world average of 1.5 to 2 items per person and lower than the national average (3.4 items) [57]. This suggests that the infectious department at Imam Khomeini Hospital in Jiroft City is effectively managing antibiotic usage, potentially leading to better outcomes for patients and helping to combat antibiotic resistance. It also indicates that there may be differences in prescribing practices between regions or hospitals within the country. Further research could explore the reasons behind these variations and identify best practices for antibiotic stewardship in healthcare settings.

It is also in line with the average of developing countries such as Yemen, Bangladesh, Malaysia, Nigeria, and Ecuador (1.3-2.3) (42, 35). This index is lower than the average done by Amani *et al*. in Ardabil city, and in their study announced an average of 3.6 characters in each version [62].

The highest frequency of prescribed antibiotics was related to the autumn season. This could be due to a variety of factors. For one, the autumn season is typically when cold and flu season begins, leading to an increase in respiratory infections that may require antibiotics for treatment. Additionally, as the weather gets colder and people spend more time indoors, there may be a higher likelihood of spreading infections among individuals. Furthermore, seasonal allergies can also peak in the autumn months, leading to sinus infections and other conditions that may require antibiotic treatment. Overall, the combination of these factors likely contributes to the higher frequency of prescribed antibiotics during the autumn season.

In Hosseinzadeh's study [63], the highest numberof antibiotic prescriptions was related to autumn and then winter. Also, in the study of Golfshan *et al*., the highest amount of antibiotic prescriptions are related to the autumn season, but the number of antibiotics prescribed was not significantly related to the season of hospitalization of the patients [64].

The highest number of antibiotics was prescribed by the internal specialist. In this study, most antibiotics were consumed by the internal service, followed by obstetrics and gynecology, and then by the infectious service. However, specialty used antibiotics more correctly but didn’t investigate tho65]. In Alavi Moghadam's study, most antibiotics were prescribed by internal medicine, emergency, and infectious medicine specialists, respectively [12].

5. STUDY LIMITATIONS

This study has limitations. Among the limitations of the current research, the following can be mentioned.

1- This research was limited in comparing the results with other related studies. This limitation has been due to the lack of resources and associated studies.

2- This research was conductedcross-sectionally. This makes it difficult to draw conclusions about causality.

3- The results of the present study can be generalized to patients hospitalized in the infectious department of Imam Khomeini Hospital (RA). Therefore, the generalization of the findings of the present study is limited, and caution should be taken when generalizing the results.

CONCLUSION

The average number of antibiotic items consumed per person in the infectious department of Imam Khomeini Hospital in Jiroft City was 1.95 ± 0.4. The predominant antibiotic used in this study was ceftriaxone, representing over 70% of all prescribed antibiotics. The senior managers of the health department and the vice president of food and drugs must have more control over the number of antibiotic prescriptions in hospitals to prevent irrational and inappropriate prescriptions of antibiotics. It is suggested that treating physicians seek help from clinical pharmacists to select antibiotics for patients. Also, more studies should be conducted on the prevalence of antibiotic use and prescribed daily doses in different departments of hospitals and outpatients on a national basis. The necessary solutions for the rational and correct administration of antibiotics in different departments and hospitals should be investigated. For the treatment team in charge of treating people, important educational programs should be planned and implemented.

To improve antibiotic prescribing management, healthcare providers should implement several concrete steps. First and foremost, it is essential to establish antimicrobial stewardship programs within healthcare facilities. These programs can help monitor antibiotic usage, educate healthcare providers on appropriate prescribing practices, and provide feedback on their performance. Furthermore, implementing guidelines and protocols for antibiotic prescribing can help standardize care and ensure that antibiotics are only used when necessary. Additionally, utilizing diagnostic tools such as rapid testing for bacterial infections can assist healthcare providers in making informed decisions about antibiotic therapy. Lastly, promoting patient education about the risks of overprescribing antibiotics and the importance of completing a full course of treatment can help reduce inappropriate use. By taking these proactive measures, healthcare providers can effectively manage antibiotic prescribing and combat the growing issue of antibiotic resistance.

ABBREVIATION

ADR	=	Adverse Reactions

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This project was approved by the ethics committee of Jiroft University of Medical Sciences under the ethics code IR.JMU.REC.1400.060. The principle of maintaining the confidentiality of information was strictly followed during the data collection process.

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committees and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

The researcher referred to the medical records unit of the hospital, extracted the necessary information from the patient's files, and added it to the researcher's checklist, which is why informed consent was not obtained.

STANDARDS OF REPORTING

STROBE guidelines have been followed.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from the corresponding author [S.D] upon reasonable request.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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