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Prescribing pattern of antibiotic misuse in a hospital in the north of Iran

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Abstract

Background: Improper prescription of the type, dose, and duration of antibiotics imposes a financial burden on the health system, can cause many side effects for the patient, and can lead to the emergence of drug-resistant bacteria. This study aimed to determine the profile of prescribing antibiotics in different wards of a hospital and compare it with references.

Methods: This study was conducted on the recorded information of 342 patients in the emergency, infectious diseases, pulmonary, and surgical wards of Sayad Shirazi Hospital in Gorgan (north of Iran) in 2019-2020. The type, dose, and duration of the prescribed antibiotics were extracted from each patient's file and compared with references. The compatibility and inconsistency of the prescribed antibiotics were identified and analyzed accordingly.

Results: A total of 13 types of antibiotics were prescribed for the patients. There was a 43.7% inconsistency in antibiotic prescription with the references. The most prescribed antibiotic was ceftriaxone (25.6%). Ceftriaxone (11.26%), followed by cefazolin (8.30%), had the most inconsistency in prescription. The most inconsistency in total was respectively observed in the pulmonary (47.9%), general surgery (44.8%), emergency (44.4%), and infectious diseases wards (40.6%). No significant difference was observed between the wards in terms of the total inconsistency of prescribed antibiotics with the references (P = 0.692).

Conclusion: The most prescribed antibiotic was ceftriaxone. A high percentage of its prescriptions are without indication and are actually prescribed as empiric. Therefore, it is necessary to monitor the prescription of antibiotics in medical centers based on the indications and available evidence.

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Highlights

What is current knowledge?

•There was a 43.7% inconsistency in antibiotic prescription with the references.

•The most prescribed antibiotic was ceftriaxone (25.6%).

•Ceftriaxone (11.26%), followed by cefazolin (8.30%), had the most inconsistency in prescription.

What is new here?

•The most inconsistency was observed in the pulmonary ward (47.9%).

Introduction

According to the World Health Organization (WHO), for rational drug use, it is necessary to use drugs with appropriate therapeutic effects that can meet the clinical needs of patients with the fewest complications and the lowest cost; it is also imperative to pay attention to the dose and duration of the drug use (1). It is sometimes believed that the accumulation of antibiotics in the tissues of the host body can strengthen the body's natural defense mechanisms and help kill the bacterial agents that have accumulated at the site (2).

In many countries, antibiotics constitute about 30-50% of prescription drugs among therapeutic agents. Although antibiotics are necessary for most bacterial infections and do not pose a threat to the patient's life, most studies have shown that 30-60% of prescriptions were inappropriate and often prescribed by the doctor or through self-medication (3). Inappropriate administration of antibiotics will cause drug resistance. Antibiotic resistance resulted in 700,000 deaths in 2019 and is estimated to be the cause of 10 million deaths in 2023 worldwide (4).

In developing countries, 79-84% of all patients are prescribed antibiotics (5). Improper administration of antibiotics (the selection of inappropriate antibiotics, administration of inadequate doses of drugs, or failure to administer drugs at appropriate times) can increase the prevalence of antibiotic-resistant strains, prolong hospital stays, cause side effects, and waste medical funds (6).

It is necessary to monitor the prescription of antibiotics in specific periods in order to prevent financial damage and losses in the field of health. The Sayad Shirazi Hospital (Gorgan, Iran) has more than 25 wards, and the highest amount of antibiotic administration is observed in the pulmonary, infectious diseases, general surgery, and emergency wards. Therefore, this study aimed to evaluate antibiotic misuse in terms of the type of antibiotic, prescribed dose, and duration of antibiotic consumption in this hospital.

Methods

Study population

In this cross-sectional study, the population included patients referred to the emergency, pulmonary, infectious diseases, and general surgery wards of Sayad Shirazi Hospital in Gorgan, northern Iran, in 2019-2020. The information was extracted from the patients' files according to the inclusion and exclusion criteria. The inclusion criteria were a definitive diagnosis, receiving at least 1 antibiotic during hospitalization, and being admitted to the emergency, pulmonary, infectious diseases, or general surgery wards. The exclusion criteria were the use of no antibiotics and no definitive diagnosis.

Sample size

The sample size was calculated with a 95% confidence and a 5% error coefficient using the following formula:

$$n = (z)2 \times p\,(1–p)/d2 = 385$$

Then, the obtained number was optimized using the limited sample size formula as follows:

$$n' = n/(1+[(n-1)/N]) = 342$$

Based on the proportion of patients in each ward, 105 patients from the emergency ward, 97 from the surgical ward, 84 patients from the infectious diseases ward, and 56 patients from the pulmonary ward were randomly selected based on multistage random sampling (7).

Data extraction

After applying the inclusion and exclusion criteria, the patients' information, including definitive diagnosis, hospitalization ward, length of hospitalization, age, sex, type of antibiotic, dose of antibiotic, and duration of antibiotic use, was extracted. Indication of the type of antibiotic, antibiotic dose, and duration of treatment for each disease was compared to guidelines (8, 9).

Statistical analysis

The data were analyzed using IBM SPSS v. 20 software (IBM Corp., Armonk, NY, USA), and the results were considered significant where the P-value was < 0.05. Chi-square and Fisher's exact tests were used to analyze the qualitative variables. The quantitative variables were compared using the independent *t*-test and one-way analysis of variance (ANOVA).

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Results

Evaluation of antibiotic use in all the wards

A total of 344 people were included in this study; 107 patients in the 4 wards took only 1 type of antibiotic, and for the remaining 237 patients, more than 1 type of antibiotic was prescribed. Of the patients, 163 were men (47.4%) and 181 were women (52.6%). The mean ± standard division (SD) of age for all the subjects was 53.64 ± 18.68 years. The mean length of hospitalization for all the patients was 6.68 ± 8.7 days. Thirteen types of antibiotics were prescribed. The frequency of administration of each antibiotic is shown in Figure 1. Out of 675 cases of antibiotics, in 295 cases (43.7%), there was noncompliance with the reference at 1 level (antibiotic type, prescribed dose, and duration of use). The frequency of the conformity of type, dose, and duration of antibiotic use with the references is shown in Table 1.

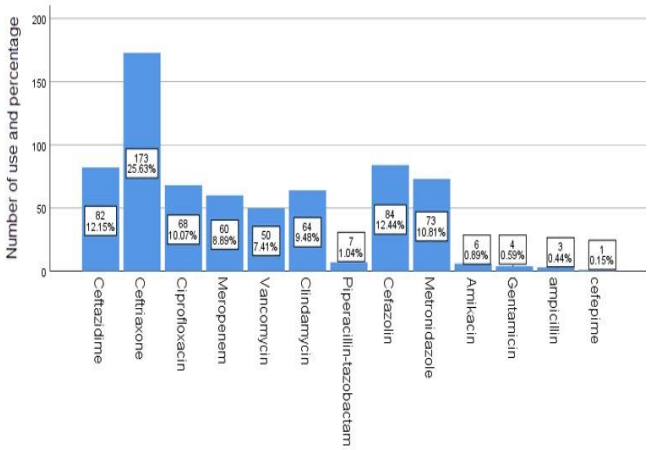

Figure 1. Frequency of prescribing different antibiotics in the studied population

Table 1. Frequency of matching the pattern of consumption of antibiotics with the references in all 4 studied wards

	It matches; N (%)	It does not match; N (%)
Type of antibiotic	649 (96.1)	26 (3.9)
Dose of antibiotics	569 (84.3)	106 (15.7)
Duration of consumption	454 (67.4)	220 (32.6)

Pulmonary ward

The hospitalized patients included 25 men (44.6%) and 31 women (55.4%). The mean age of the patients was 59.91 ± 14.08 years. The mean length of hospitalization was 6.28 ± 0.4 days. The prescribed antibiotics included ceftazidime in 33 cases (46.5%), ceftriaxone in 29 cases (40.8%), meropenem in 7 cases (9.9%), ciprofloxacin in 1 case (1.4%), and vancomycin in 1 (1.4%). The dose prescribed for pulmonary patients during hospitalization was as follows: ceftazidime 15.94 ± 1.76 g, ceftriaxone 7.24 ± 0.88 g, meropenem 14.43 ± 1.87 g, ciprofloxacin 22 g, and vancomycin 22 g.

Table 2, presents the frequency of matching the type, dose, and duration of antibiotic use prescribed in the pulmonary ward with the references. Furthermore, Figure 2, displays the correspondence of the type of antibiotic prescribed with the references based on the type of disease. The chi-square test showed that the rate of mismatch between the type of antibiotic prescribed and the references based on the type of disease was statistically significant (P = 0.009). Moreover, Figure 3, depicts the correspondence of the antibiotics dose prescribed with the references based on the type of disease. The results of the chi-square test indicated that the rate of discrepancy between the prescribed antibiotic dose and the references based on the type of disease was statistically significant (P = 0.011). Figure 4, illustrates the correspondence of the duration of antibiotic administration with the references based on the type of disease. The results of the chi-square test revealed that the inconsistency of the duration of antibiotic administration with the references based on the type of disease is statistically significant (P = 0.001).

Table 2. The frequency of matching the type, dose, and duration of use of antibiotics prescribed in the pulmonary ward with the references

	It matches; N (%)	It does not match; N (%)
Type of antibiotic	57 (80.3)	14 (19.7)
Dose of antibiotics	55 (77.5)	16 (22.5)
Duration of consumption	39 (54.9)	32 (45.1)

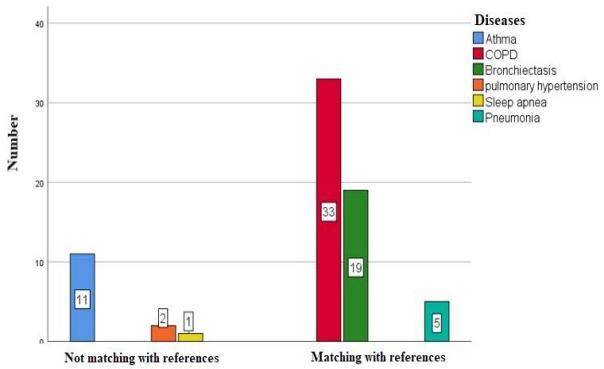

Figure 2. The correspondence of the type of antibiotic prescribed with the references based on the type of disease in the pulmonary ward

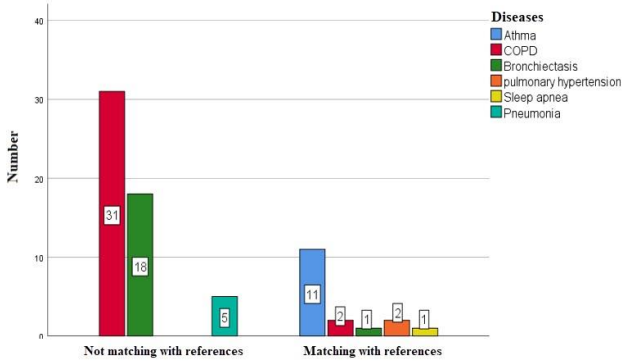

Figure 3. The correspondence of the antibiotics dose prescribed with the references based on the type of disease in the pulmonary ward

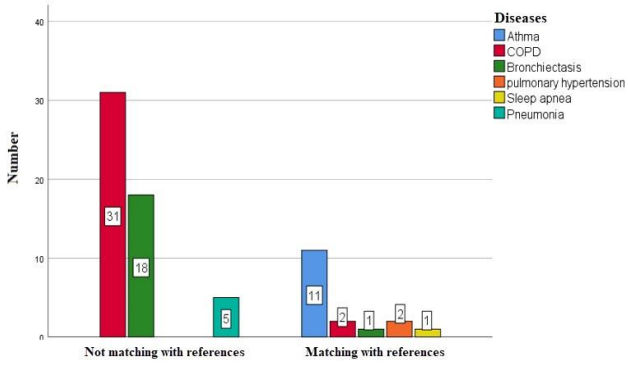

Figure 4. The correspondence of the duration of antibiotic administration prescribed with the references based on the type of disease in the pulmonary ward

The hospitalized patients included 39 men (46.4%) and 45 women (53.6%). The mean age of the patients was 51.04 ± 17.90 years. The mean length of hospitalization was 8.98 ± 6.6 days. The prescribed antibiotics included ceftazidime in 17 cases (8.2%), ceftriaxone in 47 cases (22.7%), meropenem in 25 cases (12.1%), ciprofloxacin in 33 cases (15.9%), vancomycin in 22 Case (10.6%), clindamycin in 29 cases (14%), piperacillin-tazobactam in 7 cases (3.4%), cefazolin in 2 cases (1%), metronidazole in 19 cases (9.2%), amikacin in 4 cases (1.9%), gentamicin in 1 case (0.5%), and ampicillin in 1 case (0.5%). The dose prescribed for the patients in the infectious diseases ward during the period of hospitalization by the type of antibiotic was as follows: ceftazidime 18.94 ± 3.95 g, ceftriaxone 0.9 ± 1.26 g, meropenem 23.44 ± 3.48 g, ciprofloxacin 23.36 ± 3.42 g, vancomycin 26.4 ± 4.3 g, clindamycin 91 ± 17.17 g, piperacillin-tazobactam 31.9 ± 35.14 g, cefazolin 7.9 g, metronidazole 10.68. ± 2.6 g, and amikacin 10 ± 3.81 g.

Table 3, lists the frequency of matching the type, dose, and duration of antibiotics prescribed in the infectious ward with the references. The correspondence of the type of antibiotic prescribed with the references based on the type of disease is shown in Figure 5. As can be seen, a mismatch in the prescribed antibiotics occurred in 3 diseases: cellulite, brucellosis, and pneumonia, but the difference was not statistically significant (P = 0.95). Figure

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6, displays the correlation of the prescribed antibiotic dose with the references based on the type of disease. Evidently, the highest rate of noncompliance between the prescribed antibiotic dose and the references belongs to diabetic foot infection and, then, colitis. The result of the chi-square test revealed that the amount of discrepancy between the prescribed antibiotic dose and the references based on the type of disease is not statistically significant (P = 0.1). Figure 7, depicts the correlation of the duration of antibiotic administration with the references based on the type of disease. Based on the chi-square test results, the inconsistency of the duration of antibiotic administration with the references based on the type of disease was not statistically significant (P = 0.4).

Table 3. The frequency of matching the type, dose, and duration of use of antibiotics prescribed in the infectious diseases ward with the references

	It matches; N (%)	It does not match; N (%)
Type of antibiotic	203 (98.1)	4 (1.9)
Dose of antibiotics	190 (91.8)	17 (8.2)
Duration of consumption	134 (64.7)	73 (35.3)

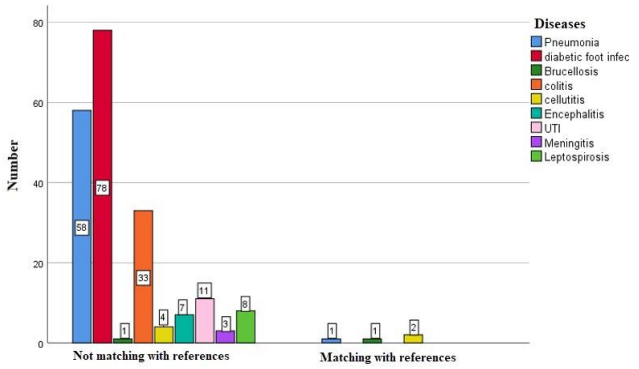

Figure 5. The correspondence of the type of antibiotic prescribed with the references based on the type of disease in the infectious diseases ward

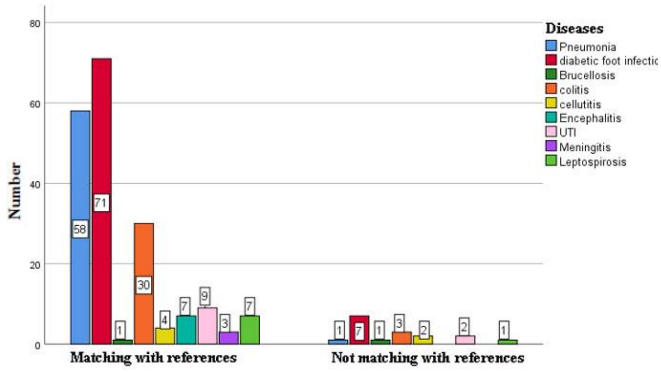

Figure 6. The correspondence of the dose of antibiotic prescribed with the references based on the type of disease in the infectious diseases ward

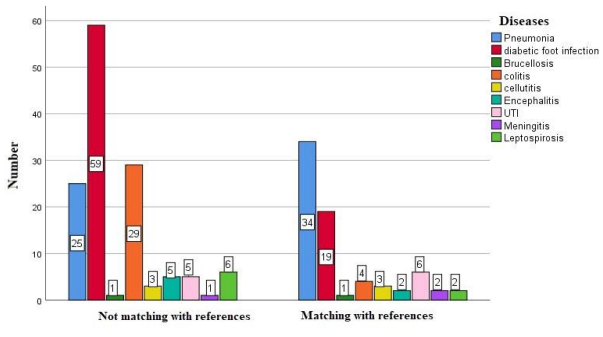

Figure 7. The correlation of the duration of antibiotic administration with the references based on the type of disease in the infectious diseases ward

General surgery ward

From this ward, 97 patients for whom at least 1 dose of antibiotics was prescribed were included. The hospitalized patients included 38 (39.2%) men and 59 (60.8%) women. The mean age of the patients was 44.07 ± 15.90 years. The mean length of hospitalization was 2.59 ± 1.7. The prescribed antibiotics were ceftriaxone in 36 (23.4%) cases, ciprofloxacin in 2 (1.3%) cases, clindamycin in 1 (0.6%) case, cefazolin in 81 (52.6%) cases, metronidazole in 31 (20.1%) cases, and gentamicin in 3 (1.9%) cases. The dose prescribed for the patients in the infectious diseases ward during hospitalization by the antibiotic type was as follows: ceftriaxone 4.94 ± 0.66 g, ciprofloxacin 2 g, clindamycin 1 g, cefazolin 3.29 ± 0.28 g, metronidazole 7.35 ± 1.06 g, and gentamicin 1 g.

The frequency of matching the type, dose, and duration of antibiotics prescribed in the general surgery ward with the reference is presented in Table 4. There was no relationship between the types of antibiotic used in the surgical ward and the disease under surgery. Thus, Figure 8 shows the type and frequency of the antibiotics used in the general surgical ward. The correlation of the prescribed antibiotic dose with the references based on the type of disease is illustrated in Figure 9. The highest rate of mismatch of the prescribed antibiotics dose with the references belongs to the calculus of the gallbladder. The amount of discrepancy between the prescribed antibiotic dose and the references based on the type of disease is not statistically significant (P = 0.12). Furthermore, Figure 10, illustrates the correlation of the duration of antibiotic administration with the references based on the type of disease. As it is clear in Figure 10, the highest rate of inconsistency of the prescribed antibiotic duration with the reference is related to cholecystitis and, then, calculus of the gallbladder. The result of the statistical analysis indicated that the amount of discrepancy between the duration of prescribed antibiotics and the references based on the type of disease is not significant (P = 0.15).

Table 4. The frequency of matching the type, dose, and duration of use of antibiotics prescribed in the general surgery ward with the references

	It matches; N (%)	It does not match; N (%)
Type of antibiotic	154 (100)	0 (0)
Dose of antibiotics	101 (65.6)	53 (34.4)
Duration of consumption	125 (81.2)	29 (18.8)

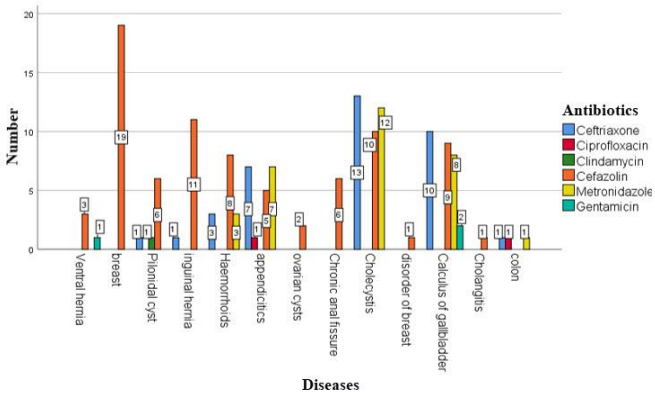

Figure 8. The type and frequency of prescribed antibiotics based on the type of disease in the general surgery ward

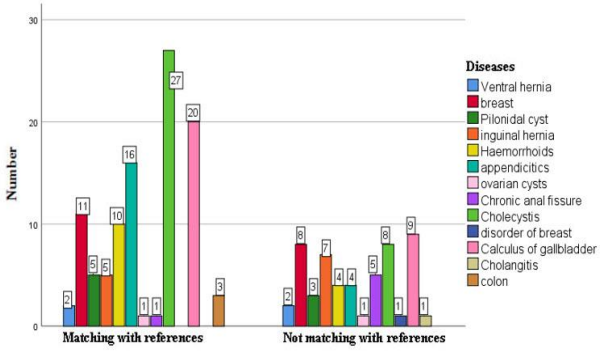

Figure 9. The correspondence of the dose of antibiotic prescribed with the references based on the type of disease in the general surgery ward

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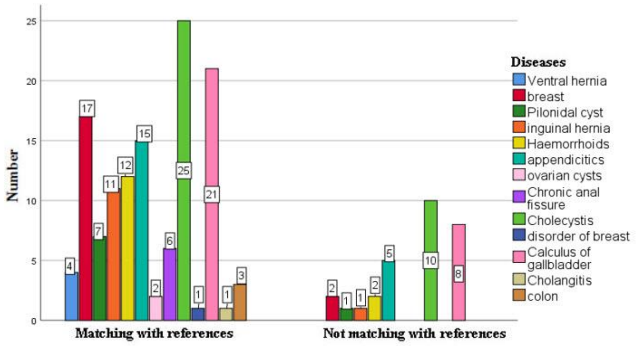

Figure 10. The correspondence of the duration of antibiotic prescribed with the references based on the type of disease in the general surgery ward

Emergency ward

A total of 107 patients with at least 1 dose of antibiotic were included. The hospitalized patients included 61 (57%) men and 46 (43%) women. The mean age of the patients was 61.13 ± 19.5 years. The mean length of hospitalization was 3.78 ± 6.8 days. The prescribed antibiotics included ceftazidime in 32 (13.1%) cases, ceftriaxone in 61 (25.1%) cases, ciprofloxacin in 32 (13.2%) cases, meropenem in 28 (11.5%) cases, vancomycin in 27 (11.1%) cases, clindamycin in 34 (0.14%) cases, cefazolin in 1 (0.4%) case, metronidazole in 23 (9.5%) cases, amikacin in 2 (0.8%) cases, ampicillin in 2 (0.8%) cases, and cefepime in 1 (0.4%) case. The dose prescribed for patients in the surgical ward during hospitalization by the antibiotic type was as follows: ceftazidime 7.22 ± 1.38 g, ceftriaxone 4.87 ± 0.73 g, ciprofloxacin 4.87 ± 0.78 g, and meropenem 8.53 ± 2.67 g.

Table 5, lists the frequency of matching the type, dose, and duration of antibiotics prescribed in the emergency ward with the references. The correspondence of the type of antibiotic prescribed with the references based on the type of disease is shown in Figure 11. There was a mismatch in the type of antibiotic prescribed for unstable angina, anemia, stroke, stroke, and electrolyte disorders, which was statistically significant (P < 0.001). The correlation of the prescribed antibiotic dose with the references based on the type of disease is depicted in Figure 12. There was a mismatch in the prescribed antibiotic dose in cholecystitis, which was not statistically significant (P = 0.81). Figure 13 also shows the correlation of the duration of antibiotic administration with the references based on the type of disease. The highest rate of inconsistency of the prescribed antibiotic duration with the references was related to encephalitis. In addition, there was a 100% mismatch in peritonitis. The results revealed that the rate of discrepancy between the duration of prescribed antibiotics and the references based on the type of disease is not statistically significant (P = 0.19).

Table 5. The frequency of matching the type, dose, and duration of antibiotics prescribed in the emergency ward with the references

	It matches; N (%)	It does not match; N (%)
Type of antibiotic	235 (96.7)	8 (3.3)
Dose of antibiotics	230 (94.7)	13 (5.3)
Duration of consumption	153 (63.2)	89 (36.8)

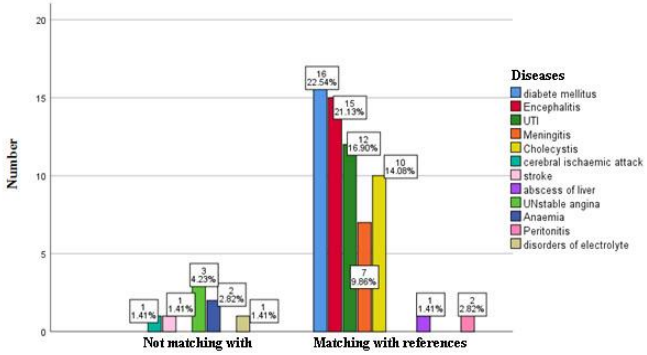

Figure 11. The correspondence of the type of antibiotic prescribed with the references based on the type of disease in the emergency ward

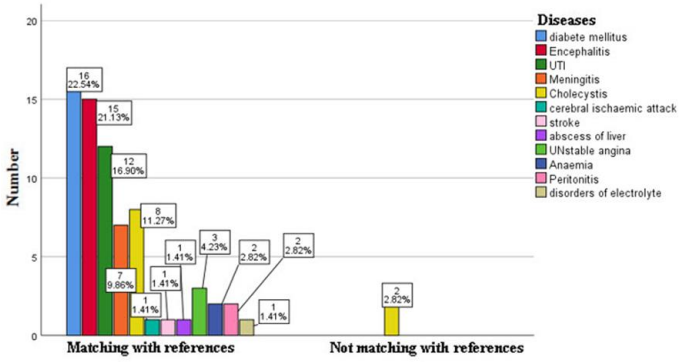

Figure 12. The correspondence of the dose of antibiotic prescribed with the references based on the type of disease in the emergency ward

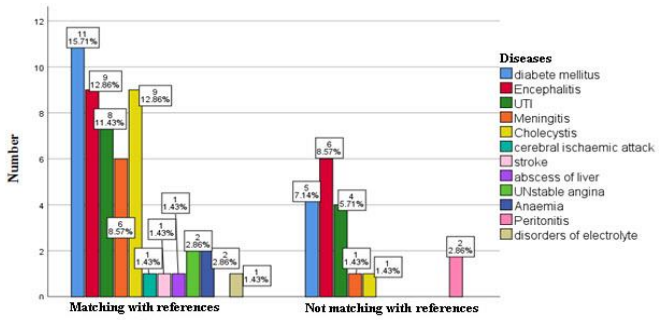

Figure 13. The correlation of the duration of antibiotic administration with the references based on the type of disease in the emergency ward

Discussion

Antibiotic resistance is increasing all over the world and has caused problems for the medical community. A major cause of the occurrence of antibiotic-resistant bacteria is the incorrect use of antibiotics; the inappropriate prescription of the type of antibiotics has an especially significant contribution to this problem. The rate of inappropriate prescription of antibiotics has been reported to be 40% to 91% in different studies (10). Inappropriate antibiotic prescription was 32.3% in a study in India, 41% in a study in the US (11), and 26% in a study in Thailand (12), while this rate was 43.7% for the antibiotics used in our study.

The results of a study revealed that 20.4% of the patients who received antibiotics did not have an indication for antibiotic use, 51.9% had incorrect drug type, 18.1% had improper dosage, and 6.5% had an incorrect duration of antibiotic use (13). In the present study, in 22 cases (3.26%), there was no indication for prescribing antibiotics, all of which were related to the pulmonary ward. In 43.7% of the cases of incorrect prescription of antibiotics, 3.9% were related to the type of antibiotic, 15.7% to the dose of antibiotic, and 32.6% to the duration of antibiotic use. Therefore, the findings of the present study are consistent with the aforementioned study in terms of antibiotic dosage but differ in terms of the type and duration of antibiotic use.

Gholami et al. (6) showed that, in general, 40.5% of antibiotic prescriptions were inappropriate in terms of type, dose, and duration of antibiotic use. In the current study, 43.7% of the antibiotics prescribed were inappropriate in terms of the type, dose, and duration of antibiotic used, which was consistent with the findings of the aforementioned study.

In a study, 37% of the children who were admitted to the clinic or emergency department of the hospital for 1 year and treated with antibiotics in the first 7 days of each month were prescribed antibiotics incorrectly (14). In the current study, the incorrect prescription of antibiotics was observed in 3.9% of the cases, which is a very low rate compared to the aforementioned study. In the current study, the correctness of prescribing antibiotics was determined based on the final diagnosis of the disease and medical references, while in the aforementioned study, it was determined based on the culture of specimens.

The most prescribed antibiotic was ceftriaxone (25.6%) in the present study, which was consistent with the results obtained in Kosovo (15), Riyadh (16), Mexico City (17), Tehran (6), and Shahrekord (Iran) (18). Moreover, ceftriaxone (11.26%) had the most inconsistency in prescription, the most important reason for which is its use as an empiric therapy (19). In this regard, the result of a study showed that 87.3% of prescribed ceftriaxone was empiric, and, with a 35% frequency, it was the most commonly administrated antibiotic for the treatment of pneumonia (20). In line with the result of the latter study, the current study showed the most inconsistency in antibiotic administration in the pulmonary ward. Furthermore, ceftriaxone (40.8%) had the most inconsistency in

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administration after ceftazidime (46.5%). In addition to antibiotic resistance, the most important point to keep in mind is that ceftriaxone, like many other drugs, has side effects that may result from inappropriate administration (21, 22).

As a limitation of this study, the discrepancy between the prescribed antibiotics and the references may be due to the complexity of the patient's disease, and the analysis of the use of appropriate antibiotics in these conditions is complicated. In this study, the prescription of antibiotics was examined based on each disease or each ward, and therefore, it was difficult to categorize patients who were suffering from several diseases, and this categorization was not performed.

Conclusion

There was a 43.7% noncompliance in antibiotic use with the references. Considering the existing heterogeneity regarding the type, dose, and duration of antibiotic administration compared to the guidelines, it seems necessary to perform an antibiotic sensitivity test before prescribing antibiotics. Since the most prescribed antibiotic was ceftriaxone, a high percentage of its prescriptions were without indication, and it was actually prescribed as an empiric, it is necessary to monitor the prescription of antibiotics in medical centers based on indications and the available evidence.

Acknowledgement

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Ethical statement

This study was approved by the Ethics Committee of Golestan University of Medical Sciences (IR.GOUMS.REC.1399.350).

Conflicts of interest

The authors declare that there is no conflict of interest.

Author contributions

Esmat Heydari: Data collection; Hamed Kalani: Analysis and interpretation of results; Somayyeh Pasandi Yasaghi: Writing the manuscript; Roghieh Golsha: Study conception and design.

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