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Antimicrobial Consumption in an Intensive Care Units: A Retrospective Study of Four Hospitals in Sana'a City, Yemen

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الملخـــــــص

مقدمة:

دراسة استخدام الأدوية, وخاصة المضادات الحيوية, هي أداة هامة لدراسة الاستخدام السريري للأدوية وتأثيرها على نظام الرعاية الصحية. يؤدي الاستخدام العشوائي للمضادات الحيوية إلى عدد من النتائج السلبية من حيث التكلفة وتداخل الأدوية ومدة البقاء في المستشفى ومقاومة البكتيريا والأعباء الاقتصادية الكبيرة على أنظمة الرعاية الصحية. هدفت هذه الدراسة إلى تحديد أنماط انتشار استهلاك المضادات الحيوية في وحدات العناية المركزة بالمستشفيات في مدينة صنعاء باليمن.

طرق البحث :

تم إجراء دراسة استعادية في أربعة مستشفيات رئيسية في مدينة صنعاء في اليمن خلال يناير إلى مارس ٢٠٢٢. تم جمع البيانات الخاصة بسجلات المرضى ووصفات المضادات الحيوية واستهلاك المضادات الحيوية من السجلات الطبية. تم تطبيق الإحصاءات الوصفي على البيانات المجمعة وتم الحصول على موافقة اللجنة الأخلاقية في المؤسسية.

النتائج:

تم تضمين مجموع ٢٥٠ مريضًا في الدراسة, (٥١,٢%) إناث و (٤٨,٨%) ذكور في جميع المستشفيات مع فئات عمرية تتراوح بين ١٥ سنة وأكثر من ٦٠ سنة. بلغ المجموع اليومي للمرضى في وحدات العناية المركزة ١٨٥١ يومًا, مما أدى إلى متوسط مدة الإقامة ٧,٤ يوم لكل مريض, وبالإضافة إلى ذلك, بلغ متوسط عدد المضادات الحيوية الموصوفة لكل مريض ٢, ومتوسط استهلاك المضادات الحيوية لكل مريض ٧جرام. أكثر المضادات الحيوية الموصوفة شيوعًا كانت السيفترياكسون (٢١,٧٥%), الميروبينيم (١٢,٧%), والموكسيفلوكساسين (١٠,١٧%). كانت السيفالوسبورينات المجموعة الأكثر استهلاكًا شيوعًا (٣٣,٦٦%), تليها الفلوروكينولونات (٢٣,٩٥%), الكاربابينيمات (١٣,٣٧%), الغليكوببتيدات (٧,٩٨%), والبنسلينات (٨,٨٥%).

الاستنتاج:

توفر الدراسة نظرة شاملة على استخدام المضادات الحيوية في مرضى وحدات العناية المركزة في مدينة صنعاء, اليمن. بالإضافة إلى ذلك, توجد اختلافات في كل من انتشار استخدام المضادات الحيوية وأنماط وصفها بين المستشفيات المختلفة. من الضروري مراقبة وتحسين ممارسات وصف المضادات الحيوية في وحدات العناية المركزة بشكل مستمر لمواجهة تطور مقاومة الميكروبات الحيوية والمضاعفات الأخرى.

الكلمات الرئيسية:

استخدام المضادات الحيوية, مرضى وحدات العناية المركزة, مدينة صنعاء, اليمن, مضادات الحيوية.

Abstract:

Background:

Drug utilization study, particularly antimicrobials, is an important tool to study the clinical use of drugs and its impact on healthcare System. The irrational use of antimicrobials leads to a number of consequences in term of cost, drug interactions, hospital stay, bacterial resistance, and a substantial economic burden on health care systems. This study aimed to determine the prevalence patterns of antimicrobial consumption in ICUs of hospitals in Sana'a city, Yemen.

Methods:

A retrospective study was conducted in four main hospitals in Sana'a city, Yemen, during January to March 2022. Data on patient demographics, antimicrobial prescriptions, and antimicrobial consumption were collected from medical records. Descriptive statistics were applied to the collected data and institutional ethical committee approval was obtained.

Results:

A total of 250 patients were included in the study, (51.2%) females and (48.8%) males across all hospitals with age categories ranged from 15 years to over 60 years. The cumulative patient-days for all ICU patients was 1851 days, resulting in an average admission duration of 7.4 days per patient moreover, the average number of prescribed antimicrobials per patient was 2, and the average of antimicrobial consumption per patient was 0.7 grams. The most commonly prescribed antimicrobials were Ceftriaxone (21.75%), Meropenem (12.7%), and Moxifloxacin (10.17%). Cephalosporins were the most commonly consumed group (33.66%), followed by Fluoroquinolones (23.95%), Carbapenems (13.37%), Glycopeptides (7.98%), and Penicillins (8.85%).

Conclusion:

The study provides insights into the utilization of Antibiotics in ICU patients in Sana'a city, Yemen. In addition, variations in both prevalence of antibiotic use and in prescribing patterns among different hospitals. It is necessary for continuous monitoring and improvement of antibiotic prescribing practices in ICUs to combat the development of antimicrobial resistance and other complications.

Key words:

Antibiotics Utilization, ICU Patients, Sana'a City, Yemen, Antimicrobial Agents.

Introduction:

Antimicrobials, which are therapeutic drugs, are extensively misused worldwide (5-1). While the adverse effects associated with antimicrobials are often mild, there are instances where they can be life-threatening and require immediate medical attention [3 ,2]. The prevalent use of antimicrobial agents, particularly broad-spectrum ones, may be attributed to physicians' concern for effectively treating severely ill patients. However, it is crucial to acknowledge that this extensive usage is closely intertwined with the global issue of antimicrobial resistance (AMR) (10-6) Ecological evidence supports the notion that countries with higher antimicrobial consumption also tend to exhibit higher levels of AMR [7]. The worldwide emergence of AMR has led to increased patient morbidity, mortality, and healthcare costs (11-7). Given the escalating concern of AMR worldwide. This study aimed to determine the prevalence patterns of antimicrobial consumption in ICUs of hospitals in Sana'a city, Yemen.

Methods:

Study Design: A retrospective study was conducted using medical records of all ICU admissions during 8/ January to 29/March 2022.
Study Area: The study was carried out in four hospitals located in Sana'a City, Yemen. These included one public hospital (Al-Sabeen hospital-70H) and three private hospitals (University of Science Teaching Hospital -USTH, Yemen German Hospital-YGH, Royal Hospital-RH).
Study Population: The study included all patients admitted to the ICUs of these hospitals during 2022. Data was collected manually from patient records, except for USTH and RH, where electronic data was available.
Sample Data: The study included adult patients who were admitted to ICUs and received prescribed Antibiotics in the four hospitals during 2022.
Excluded Data: Children admitted to ICUs and patients with missing data on prescribed and received medications were excluded from the study.
Data Collection: Information on ICU patients was extracted from the ICU patient registered files to a structured questionnaire. A structured questionnaire including variables such as patient age, Gender, admission and discharge dates, duration of hospital stay, prescribed Antibiotics (name, strength, type), antibiotic dosage (frequency and duration), route of administration (oral, IM, IV), antibiotic scientific name, class, and subclass.

Results:

A retrospective study was carried out during January to March 2022 and data of patients admitted to ICU hospitals in Sana'a city was collected from the records of four selected hospitals. A total of 250 patients were enrolled in the study. It was found that about (%44) 109 patients admitted to University Science and Technology Hospital (USTH), while (%26) 67 in Seventy Hospitals (70H), (%18) 44 in Yemen German Hospital (YGH), and (%12) 30 in Royal Hospital (RH) respectively. Regarding to gender distribution,

females (128 ,%51.2) and males (122 ,%48.8) among ICU patients, across all hospitals with exception in 70H all patients were females. According age categories, the range was 15 years to over 60 years, with the highest number of patients falling into the oldest age category (49.5%). On the other hand, the 44-30 years category had the lowest frequency 7.5% of the total population. Table-1

The cumulative patient-days for all ICU patients in this study was 1851 days, resulting in an average admission duration of 7.4 days per patient. Notably, Yemen German Hospital (YGH) exhibited the highest mean length of stay for patients, with an average of 11.9 days, surpassing other hospitals as indicated in Table-2.

Variables	Frequency %
Gender	
Male	122 (48.8%)
Female	128 (51.2%)
Age Group YRS	
15 - 30	108 (43%)
30-45	18 (7.5%)
.>45	124 (49.5%)
Total	**250** (100%)

Table (1) Frequency distribution of patients according to sex and age groups

Table (2) distribution of total patient day and the average for patient among hospital

Hospitals	No of ICU patients	Total patients per day	No of ICU beds	Average of admission days/patients
USTH	109 (44%)	907	24	8.3
YGH	44 (18%)	525	12	11.9
RH	30 (12%)	219	12	7.3
70H	67 (26%)	200	12	3.1
Total	**250 (100%)**	**1851**	**60**	**7.4**

The study observed a total of 501 prescribed antimicrobials for all patients, resulting in an average of 2 prescribed antimicrobials per patient, as presented in Table 3.

Table (3) distribution of consumed antimicrobial and the average for patient among hospitals

Hospitals	No of ICU patients	No of consumed antimicrobial	Average No of consumed antimicrobial /patient
USTH	109	284	2 .6
YGH	44	63	1.43
RH	30	80	2.66
70H	66	74	1.12
Total	**250**	**501**	**2**

The study findings indicated that among ICU patients, the parenteral route emerged as the predominant method for administering Antibiotics.

The total quantity of antimicrobials consumed, measured in grams, was 406.65 grams, with an average consumption of 0.7 grams per patient. Among the various Antibiotics, cephalosporin exhibited the highest average consumption across hospitals, with a reported value of 2 grams. In contrast, tetracycline had the lowest Antibiotics consumed, with a recorded value of 0.1 grams, as shown in Table 4.

Table (4) distribution of total amount and average of consumed antimicrobial among hospitals

Antibiotic	USTH	YGH	RH	70H	Total	%
Aminoglycosides	3.58	0.5	1.58	2.74	8.4	**0.47**
Carbapenem	35.7	1.5	15.1	0	52.3	**0.78**
Cephalosporins	78.8	22.25	15	46.4	162.45	**1**
Clindamycin	1.8	0.9	2.4	0	5.1	**0.5**
Fluroquinolone	45.3	4.3	7.2	0	56.8	**0.47**
Glycopeptides	20	3.5	9.75	0	33.25	**0.8**
Macrolides	1.9	0	0	0	1.9	**0.6**
Metronidazole	1	0	1.5	0	2.5	**0.5**
Linezolid	4.6	0.6	4.8	0	10	**0.6**
Penicillin	8.625	19.237	1.6	41	70.462	**1.6**
Rifamycin	0.6	0.2	0.2	0	1	**0.2**
Sulfonamide	0	0	1	0	1	**0.1**
Tetracycline	0	0.5	0	0	0.5	**0.1**
Total	**201.9**	**54.48**	**60.13**	**90.14**	**406.65**	**0.7**

The study results found that most consumed antibiotic was broad spectrum with few narrow spectrum. The most frequently utilized in this study were Ceftriaxone (21.75%), Meropenem (12.7%), Moxifloxacin (10.17%), Levofloxacin (9.38%), and Vancomycin (7.98%). Additionally, Ciprofloxacin (4.39%), Ampicillin (4.13%), and Linezolid (3.19%) were also commonly administered antimicrobials. Amoxicillin-Clavulanic acid (2.99%), Cefoperazone (2.59%), and Cefepime (2.59%) were observed to have slightly lower but notable usage rates, as presented in Table 5.

Table (5) Frequency distribution of antimicrobial utilization among study hospitals

Antimicrobials	Frequency	%	Spectrum	USTH	YGH	RH	70 H
Amikacin	9	1.79	Broad	7	0	1	1
Amoxicillin	1	0.19	Broad	1	0	0	0
Amoxicillin + Clavulanic acid	15	2.99	Broad	3	9	2	1
Amoxicillin + flucloxacillin	1	0.19	Broad	1	0	0	0
Ampicillin	21	4.19	Narrow	0	0	0	21
Ampicillin + Oxacillin	1	0.19	Broad	0	1	0	0
Azithromycin	2	0.39	Broad	2	0	0	0
Cefipime	13	2.59	Broad	3	8	2	0
Cefixime	7	1.39	Broad	4	2	1	0
Cefotaxime	15	2.98	Broad	13	0	2	0
Cefoperazone	13	2.59	Broad	11	0	2	0
Cefpirome	6	1.19	Broad	6	0	0	0
Ceftriaxone	109	21.75	Broad	44	12	6	47
Cefuroxime	6	1.19	Broad	3	3	0	0
Ciprofloxacin	22	4.39	Broad	20	2	0	0
Clindamycin	10	1.99	Broad	3	2	5	0
Clarithromycin	1	0.19	Broad	1	0	0	0
Doxycycline	3	0.59	Broad	1	1	1	0
Gentamicin	7	1.39	Broad	1	0	2	4
Imipenem/ cilastatin	6	1.19	Broad	5	1	0	0
Levofloxacin	47	9.38	Broad	39	0	8	0
Linezolid	16	3.19	Broad	7	1	8	0
Meropenem	61	12.17	Broad	42	1	18	0
Metronidazole	5	0.99	Narrow	2	0	3	0
Moxifloxacin	51	10.17	Broad	37	8	6	0

Piperacillin	4	0.79	Broad	1	3	0	0
Rifaximin	5	0.99	Broad	3	1	1	0
Sulfamethoxazole	1	0.19	Broad	0	1	0	0
Tetracycline	1	0.19	Broad	0	1	0	0
Tigecyline	1	0.19	Broad	0	0	1	0
Tobramycin	1	0.19	Broad	0	1	1	0
Vancomycin	40	7.98	Narrow	24	5	11	0
Total	**501**	**100%**		**284**	**63**	**80**	**74**

According to the pharmacological subgroup analysis, Cephalosporins was found to be the most frequently consumed antimicrobial group, 33.66% followed by Fluoroquinolones (23.95%), Carbapenems (13.37%), Glycopeptides (7.98%), Penicillin groups (8.85%) and the lowest was Sulfonamide 0.19%. Table 6.

Table (6) Frequency distribution of antibiotic consumption based on pharmacological subgroup

Antibiotic subgroup	Total freq.	%	USTH	YGH	RH	70H
Aminoglycosides	18	3.59	8	1	4	5
Carbapenem	67	13.37	47	2	18	0
Cephalosporins	169	33.66	84	25	13	47
Clindamycin	10	1.99	3	2	5	0
Fluoroquinolones	120	23.95	96	10	14	0
Glycopeptides	40	7.98	24	5	11	0
Macrolides	3	0.59	3	0	0	0
Metronidazole	5	0.99	2	0	3	0
Linezolid	16	3.19	7	1	8	0
Pencillin	43	8.85	6	13	2	22
Rifamycin	5	0.99	3	1	1	0
Sulfonamide	1	0.19	0	1	0	0
Tetracycline	4	0.79	1	2	1	0
Total	**501**	**100%**	**284**	**63**	**80**	**74**

Discussion:

Antibiotics are among the most commonly prescribed drugs in hospitals. Majority of the patients in hospitals obtain the prescription of Antibiotics without bacteriological sensitivity tests. Prescribing Antibiotics haphazardly can lead to increased antibiotic resistance and the scenario is more common in developing nations.

This study was carried out with the purpose to determine the prevalence pattern of antimicrobial consumption in ICUs of both private and public hospitals of Sana'a City, Yemen.

The demographic data of 250 patients admitted to the ICU during this study period revealed that the (%48.8) 122 were male and (%51.2) 128) were females. This finding were compared and similar with Handyal H et.al, (2019).

The total number of prescribed antimicrobials reached 501, with an average of 2 prescribed antimicrobials per patient. This highlights the need for improved antimicrobial stewardship programs to ensure appropriate and judicious use of these medications. This study showed that the average number of drugs per encounter is about 2, which is similar to the recommended limit (2) by the WHO (2001).

Furthermore, the parenteral route emerged as the most common method of antibiotic administration among ICU patients. This preference for the parenteral route may be attributed to the severity of the patients' conditions and the need for rapid and effective treatment. This findings in which the injections were most common route of antibiotic administration in hospitalized patients. Also, it might be explained that doctors being under pressure to prescribe rapid-acting drugs to get fast improvement especially in acute infections, Al-Mehdar et al. 2017.

The analysis of antimicrobial consumption by gram revealed a total consumption of 406.65 grams, with an average of 0.7 grams per patient. Cephalosporins were found to have the highest average consumption,

with 2 grams reported, while Tetracycline had the lowest amount consumed at 0.1 grams. These variations in consumption highlight the differences in prescribing practices and the preference classes of antimicrobials among healthcare providers. Various studies about Antibiotics prescribing reveals that inappropriate prescribing of Antibiotics is prevalent in Yemen regardless of public or private hospitals. No pharmacy and therapeutic committee to oversee the use and prescribing practices of Antibiotics, and lack of practice of sensitivity testing before prescribing Antibiotics contribute to inappropriate prescribing of Antibiotics. Furthermore, pediatric population are more vulnerable to the consequences due to irrational use of Antibiotics, Alshakka M et al., (2016).

In terms of specific antimicrobial agents, ceftriaxone, meropenem, and moxifloxacin were the most frequently used, with respective usage rates of 12.7 ,%21.75%, and 10.17%. The dominance of these antimicrobials could be attributed to their broad-spectrum activity and effectiveness against a wide range of pathogens commonly encountered in ICU settings. This agreement with other studies conducted in India by Handyal H et.al, (2019).

When examining antimicrobial consumption based on pharmacological subgroups, Cephalosporins were found to be the most consumed group, accounting for 33.66% of the total consumption. Fluoroquinolones followed closely behind at 23.95%, while Carbapenems, Glycopeptides, and Penicillin groups accounted for 7.98 ,%13.37%, and 8.85% respectively. These findings highlight the importance of monitoring and regulating the use of specific antimicrobial classes to mitigate the risk of antimicrobial resistance. Similar findings were obtained in other studies conducted in Aden and Thamar city, Alshakka M et al., (2016) & Al-Mehdar et al. 2017.

Overall, this study underscores the urgent need for antimicrobial stewardship programs and interventions to promote rational antimicrobial use, improve patient outcomes, and mitigate the growing threat of antimicrobial resistance in ICU settings.

Notably, the consumption of cephalosporins in this study was found to be significantly higher compared to rates reported in various international reports, including those from Saudi Arabia, Nepal, Spain, and Sierra Leone. Similarly, the consumption of Carbapenems and Vancomycin in this study exceeded the rates reported in international studies. For instance, the consumption of Carbapenems in this study (12.7%) surpassed that reported in Saudi Arabian ICUs, Romania, Spain, and Nepal. Similarly, the consumption of vancomycin in this study (7.98%) exceeded the rates reported in the above-mentioned international reports. (18-12)

Comparing the findings of this study with the study conducted in adult ICUs in Saudi Arabia and Spain, this study demonstrated higher consumption rates of Cephalosporins, Carbapenems, and Vancomycin. It is worth noting that in most international studies, Cephalosporin's are reported as the most frequently consumed antimicrobials in adult ICUs. (19)

Concerning the therapeutic/pharmacological subgroup analysis, the most frequently consumed Antibiotics were Cephalosporins, Carbapenems, Vancomycin, and other Antibiotics, predominantly administered via the parenteral route. The use of Antibiotics orally and parenterally varied, with a total of 8460 intravenous antibiotic doses and 885 oral doses per 1000 admissions per day. In contrast, a study conducted in Sierra Leone reported a lower percentage of parenteral antibiotic consumption, accounting for less than (19).%2

Conclusion:

This study provides valuable insights into antibiotic utilization among ICU patients in Sana'a city, Yemen. It reveals a significant consumption of broad-spectrum antimicrobial agents. These findings underscore the widespread use of Antibiotics and the Prevalence variations in prescribing patterns across different hospitals. They emphasize the importance of continual monitoring and enhancement of antibiotic prescribing practices in ICUs to address the emergence of antimicrobial resistance. Furthermore, the study highlights the urgent need for effective antimicrobial stewardship programs tailored to the specific antimicrobial consumption patterns observed in ICUs within these hospitals.

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