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Emirates International University
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Department of Clinical Pharmacy (Pharm.D)

Inappropriateness Dosing and IV Administration of Restricted Antimicrobial Drugs

A graduation research project submitted as partial fulfillment for the requirement of the bachelor's degree in Clinical Pharmacy (Pharm.D)

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2024-1446

Dedication

We dedicate this research to Yemen, our beloved country. Which will always and forever remain in its protection and do everything we can to advance and improve it. To our families whom surround us with their prayers as a constant shadow and support us all the time. To our lifetime in years that occurred between effort, tiredness, the sting of science and research, the hardness of war and the fight with life. Also we dedicate this work to everyone who enlightened the mind of others with his knowledge or guided the correct answer to the bewilderment of his questioners and everyone who believed in the good word and worked for it.

Acknowledgement

We praise God Almighty very much, good and blessed, filling the heavens and the earth for what we have honored with from the completion of this study, which we hope will gain His satisfaction. First and foremost, we extended our sincere thanks and deep gratitude to the Dean of the Faculty of Medicine and Health Sciences, the spiritual father of the students: prof. Dr. **Saleh Al-Dhahri**, for his unwavering support, valuable guidance, and constant encouragement, which played a pivotal role in our academic journey. Then we extend my sincere thanks and great gratitude to our head of department and our supervisor: prof. Dr. **Mokhtar Abdul Hafiz Al-Ghorafi** for his continued support, encouragement and patience all the our period of study, and to our supervisor: prof. Dr. **Mohammed Abdullah Kubas** for his efforts, guidance, observations and advice until the completion of this study as well as for his patience throughout his supervision of the study despite the multiplicity of his commitments. In this regard we would like to extend our sincere thanks and appreciation to Dr. **Naseem Tawfiq Amer** for her continuous support and generous guidance throughout our studies. Her support played a significant role in the achievement of this accomplishment. Finaly, we extend our gratitude to all the doctors, staff, and friends who supported and encouraged us throughout our studies. Your efforts and expertise over the past six years are deeply appreciated

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Abbreviations

The abbreviation	Meaning
ASHSP	American Society of Health-System Pharmacists
IV	Intravenous
MAEs	Medication administration errors
MEs	Medication Errors
NCCMERP	National Coordinating Council for Medication Error Reporting and Prevention
UK	United Kingdom
US	United States
USTH	University of Science and Technology Hospital
WHO	World Health Organization

Abstract

Background:

Inappropriate use and administration of antimicrobial agents, particularly those classified as restricted medications, is a major contributor to medication errors and patient harm. This study aims to determine the types, prevalence and incidence of these medication errors at USTH in Sanaa at Yemen.

Methods:

A retrospective cross-sectional study was conducted at USTH in Sana'a Yemen during one month from May, 1, 2024 to June, 1, 2024 for all the patients admitted to the hospital included the adult Patients, admitted to the hospital and stay at least 24 hours, receiving at least one or more of restricted antimicrobial drugs. This data was collected form the patient file, laboratory result and asked the nursing, the patient information was including gender, age, department and if in medical word or surgery. Lab result was including serum creatinine, whereas in antimicrobial we collate date, name in brand and generic, dose, frequency, reconstitution, dilution and infusion rate. All data was statically analysis by using SPSS.

Result:

A total of 142 patients were included in our study and most of them male 59.2% female 40.8%. The patients were included from various hospital departments, while the largest proportion of patients was in The ICU 63(44.4%). There were high percentage of patients who were included in our study had renal impairment 58(40.8%). The majority of patients were on 1 to 2 restricted antimicrobial [70(49.3%), 53(37.3%)] respectively. The most indications for restricted antimicrobial were Gastrointestinal infections and

surgical prophylaxis [32(22.3%) , 28(19.5%)] respectively. The most prescribed restricted antimicrobials were Meropenem 42(26.5%), Ciprofloxacin 37(23.4%). The linezolid and colistin were the lowest prescribed agents in USTH departments. The majority of patients had at least one medication error 56(39.4%) or two MEs 31(21.8%). And most of the MEs were in dose 60(42.2%), infusion rate 52(36.7%), frequency 43(30.2%).The type of MEs with each restricted antimicrobial was mentioned. As well as, the example errors and their correction. The medication errors were encounter mostly for Ciprofloxacin(50), Meropenem(45), Piperacillin/Tazobactam(26). For Ciprofloxacin the most common error was in dose [32(64%)], while Meropenem in frequency error [20(44%)]. For Piperacillin/Tazobactam the most common error was in infusion rate [9(34%)]. The dose error was the most common seen error in Fluconazole.

Conclusion:

The study highlights how crucial it is to address the challenges found in order to guarantee the safe and appropriate administration of restricted antimicrobial drugs. These measures include targeted education, technology-enabled assistance, and complete antimicrobial stewardship programs.

CHAPTER I

INTRODUCTION

Introduction

1.1 Background

A medication error is a failure in the treatment process that leads to, or has the potential to lead to, harm to the patient.

Medication errors are regarded as a serious worldwide problem in clinical practice. They are among the top 10th causes of death worldwide. They are also considered as one of the most common causes of morbidity and mortality found in hospitals. [(1)] Medication errors are defined by the National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) as 'any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. [(2)]

The American Society of Health-System Pharmacists (ASHP) classifies medication errors into the following main categories: prescribing, transcribing, dispensing, administration, monitoring, and other medication errors. [(1)]

Medication errors can occur in:

1. Choosing a medicine irrational, inappropriate, and ineffective prescribing, under prescribing and overprescribing;
2. Writing the prescription, prescription errors, including illegibility;
3. Manufacturing the formulation to be used wrong strength, contaminants or adulterants, wrong or misleading packaging;
4. Dispensing the formulation wrong drug, wrong formulation, wrong label, wrong reconstitution, wrong dilution;

5. Administering or taking the drug, wrong dose, wrong route, wrong frequency, wrong duration;
6. Monitoring therapy failing to alter therapy when required, erroneous alteration.[16]

In the United States (US), 60% of serious and life threatening medication errors in general inpatients involved IV drugs. In United Kingdom (UK), about 56% of medication errors involved IV drugs.[4] In Asian countries, such as India and Pakistan, the incidences of medication errors were even higher constituting 21.8% and 22.6% respectively. As for the Middle Eastern countries, the incident rates of MEs varied from 7.1% to 90.5% for prescribing and from 9.4% to 80% for Administration error.[5] A few reports exist on medication errors in Iranian intensive care units. In the critical care unit of a teaching hospital in Iran, 9.4% of the IV drug preparation and administration errors occurred. 33.6% of those had to do with the preparation process, while 66.4% had to do with the administration process.[6]

Medication administration errors (MAEs) are among the most common and significant types of medication errors.[5] A systematic literature review showed MAEs to have the highest prevalence, ranging from 14.3% to 70%, in comparison to the other types of errors such as prescribing error (29.8-47.8%), dispensing error (3-33.6%), and transcribing errors (10-51.8%). MAEs are defined as 'any deviation from a prescriber's valid prescription or the hospital's policy about drug administration, including failure to correctly record the administration of a medication'. They occur as a result of the failure in any of the six aspects of rightness related to patients (the right medication, the right dose, the right patient, the right route, the right time, and the right documentation). [1]

A significant portion of medication errors are related to the intravenous administration of drugs. Errors related to intravenous administration include the wrong dosage and inappropriate reconstitution, infusion rate and dilution (using the incorrect diluent or concentration).[6,7]

Inappropriate use and administration of antimicrobial drugs, particularly those considered restricted or "high-alert" medications, is a significant contributor to medication errors and patient harm. Antimicrobial agents are essential for the treatment of infectious diseases, but their misuse can lead to adverse outcomes, including treatment failures, development of antimicrobial resistance, and increased risk of adverse drug events.[8,9]

Restricted antimicrobial drugs, such as certain broad-spectrum antibiotics, antifungals, and antivirals, are often subject to additional oversight and monitoring due to their potential for causing serious harm if used incorrectly. Inappropriate prescribing, dosing, or administration of these high-risk medications can result in suboptimal therapeutic outcomes, increased length of hospital stay, and even patient mortality.[10,11]

Intravenous (IV) administration of antimicrobial agents further increases the risk of medication errors, as the complexity of the preparation and administration process introduces additional opportunities for mistakes. Errors in IV antimicrobial therapy can include incorrect drug selection, dose calculation, dilution, infusion rate, and monitoring, all of which can have severe consequences for the patient. [12]

Addressing the issue of inappropriate dosing and IV administration of restricted antimicrobial drugs requires a multifaceted approach, involving educational initiatives, implementation of clinical decision support systems, antimicrobial stewardship programs, and enhanced safety protocols.

Continuous monitoring, reporting, and analysis of medication errors related to these high-alert medications are crucial to identify systemic vulnerabilities and implement effective interventions to improve patient safety. [13,14]

1.2 Problem statement:

Medication errors are a worldwide problem and are considered among the top 10th leading causes of death. The prevalence and incidence of medication errors are high among patients, especially hospitalized patients. leading to adverse patient outcomes, increased healthcare costs, and even patient mortality. The inappropriate dosing and intravenous (IV) administration of restricted antimicrobial drugs, such as broad-spectrum antibiotics, antifungals, and antivirals, are particularly problematic, as these high-alert medications have a higher potential for causing serious harm if used incorrectly. In Yemen, no study has been found in the literature that has discussed this issue; therefore, this research project aims to address the prevalence of medication errors among hospitalized patients.

1.3 Objectives:

The present study aims to investigate the prevalence and incidence of medication administration errors involving restricted antimicrobial agents among hospitalized patients at the University of Science and Technology Hospital (USTH) in Sana'a, Yemen.

1.4 General Objective:

This study aims to evaluate the medication errors associated with the use of restricted antimicrobial drugs among hospitalized patients at USTH in Sana'a, Yemen.

1.5 Specific Objectives:

1. To evaluate the dose errors of restricted antimicrobial drugs.
2. To evaluate the frequency errors of restricted antimicrobial drugs.
3. To evaluate the reconstitution errors of restricted antimicrobial drugs.
4. To evaluate the dilution errors of restricted antimicrobial drugs.
5. To evaluate the infusion rate errors of restricted antimicrobial drugs.

After completing this research project, the findings will contribute to:

1. Increasing awareness among healthcare providers regarding the most common medication errors associated with restricted antimicrobial agents.
2. Implementing hospital policies and protocols to prevent the most commonly identified medication errors.
3. Enriching the literature with local data regarding medication errors in Yemen.

CHAPTER II

LITERATURE REVIEW

Literature Review

Pharmacotherapy is the most common therapeutic intervention in healthcare to improve health outcomes of patients. Despite the intent to benefit patients, there are many instances where effectiveness of medications is undermined by poor medication use process and practices that could promote avoidable medication errors, thus putting patients' health in jeopardy. [15]

Medication errors are regarded as a serious worldwide problem in clinical practice. They are among the top 10th causes of death worldwide. They are also considered as one of the most common causes of morbidity and mortality found in hospitals. A medication safety fact file released by the World Health Organization (WHO) in 2019 shows that medication errors harm millions of patients yearly.[1,15]

Regarding what constitutes a medication error, there is disagreement. A thorough analysis of the literature revealed that there are 26 distinct terms used to describe medication error. [16]

A medication error is defined by the United States National Coordinating Council for Medication Error Reporting and Prevention as "Any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing, order communication, product labelling, packaging, and nomenclature, compounding, dispensing, distribution, administration, education, monitoring and use".[2]

medication error can be defined as ‘a failure in the treatment process that leads to, or has the potential to lead to, harm to the patient. [3]

2.1 Common Causes of Medication Errors

Expired Drug

Usually occurs due to improper storage of preparations resulting in deterioration or use of expired drug.[3]

Incorrect Duration

Healthcare professionals make incorrect duration errors when they administer medications for a duration either longer or shorter than prescribed. [3]

Incorrect Preparation

Incorrect preparation errors usually occur with compounded prescriptions or medications that require a specific diluent for reconstitution. [18]

Incorrect Rate

Incorrect rate of administration most often occurs with medications given as IV push or infusions. The result may be significant adverse drug reactions.[18]

Incorrect Timing

Being completely accurate with scheduled doses in both home and healthcare settings is challenging. Significant alterations in the absorption of some medications occur in the presence or absence of food. The result may be underdosing or overdosing.[3]

Incorrect Patient Action

Patients incorrectly taking a medication is considered a medication error.

Known Allergen

Dispensing a drug that the patient is allergic to is often due to poor communication with the patient, inappropriate chart review, inaccurate charting, or lack of a technological interface. [13]

Known Contraindication

Review medications vigilantly for drug-drug, drug-disease, or drug-nutrient interactions**.**

Distractions

One of the significant causes of medication errors is distractions and interruptions during the prescribing process or the administration process of medications.[19]

Distortions

Most distortions originate from poor writing, misunderstood symbols, abbreviations, or improper translation.

Incorrect Dose

Incorrect dosing includes overdose, underdose, omission of, or an extra dose. Not administering a scheduled dose of a medication is an error of omission. Errors due to incorrect routes usually occur due to unclear labeling or tubing that is adaptive to multiple connectors or lines of access. Incorrect routes often result in significant morbidity and mortality.[17,18]

Incorrect Dosage Form

An incorrect dosage form occurs when a patient receives a dosage different than prescribed, such as immediate-release instead of extended-release.

Illegible Writing

Illegible writing has plagued the healthcare industry for decades. The Institute of Safe Medication Practices recommends eliminating handwritten orders and prescriptions. [19]

2.2 Impact of Administration Errors

1. Increase risk of infections and increase mortality and morbidity.
2. Increase the risk of toxicity and antimicrobial resistant.
3. Increase patients setting in a hospital.
4. Effecting on patients cost.[19]

2.3 Preventing the Administration Errors

1. Educating patients and healthcare professionals.
2. Using computerized systems.
3. Implementing medication reviews and reconciliation.[19]

Intravenous (IV) administration of antimicrobial agents further increases the risk of medication errors, as the complexity of the preparation and administration process introduces additional opportunities for mistakes. Errors in IV antimicrobial therapy can include incorrect drug selection, dose calculation, dilution, infusion rate, and monitoring, all of which can have severe consequences for the patient. [12]

> Addressing the issue of inappropriate dosing and IV administration of restricted antimicrobial drugs requires a multifaceted approach, involving educational initiatives, implementation of clinical decision support systems, antimicrobial stewardship programs, and enhanced safety protocols. Continuous monitoring, reporting, and analysis of medication errors related to these high-alert medications are crucial to identify systemic vulnerabilities and implement effective interventions to improve patient safety. [13,14]

The appropriate dosing and administration of antimicrobial drugs are crucial in ensuring effective treatment while minimizing the risk of toxicity and antimicrobial resistance.

(Unni et. al., 2023) conducted a randomized controlled trial on the impact of clinical pharmacist-led interventions on antibiotic stewardship programs in children, highlighting the role of interventions in improving antibiotic prescribing patterns.[20] Similarly,

(Li et. al., 2023) emphasized the urgent need to review and evaluate methods to reduce mortality associated with extensively drug-resistant Gram-negative bacteria-related infections post-neurosurgery.

This underscores the importance of appropriate antimicrobial therapy in challenging clinical scenarios. [21]

In the study by (Khumra et. al., 2021) explored the practice, confidence, and educational needs of hospital pharmacists in reviewing antimicrobial prescribing, underscoring the role of healthcare professionals in ensuring appropriate antimicrobial use. [22]

Additionally, (Bolla et. al., 2020), the authors emphasized the importance of flushing infusion administration sets to ensure the total dose administration of IV antimicrobial drugs. This highlights the significance of proper administration techniques in optimizing the effectiveness of antimicrobial therapy. [23]

Furthermore, (Tsolaki et. al., 2018) discussed the successful management of healthcare-associated ventriculitis and meningitis with the intraventricular administration of colistin and tigecycline, emphasizing the importance of appropriate dosing strategies. [24]

(Watson, 1979) highlighted the importance of restricting chloramphenicol dose rates in cats with renal insufficiency due to the potential toxicity of the drug.[25] Overall, the literature reviewed emphasizes the importance of appropriate dosing, administration, and stewardship of antimicrobial drugs to ensure optimal patient outcomes while addressing challenges such as antimicrobial resistance and toxicity. These findings underscore the need for continued research and interventions to enhance the appropriateness of antimicrobial drug use

CHAPTER III

METHODOLOGY

Methodology

3.1 Study design :

The study was a retrospective cross-sectional study undertaken at USTH in Sana'a, Yemen.

3.2 Study site :

USTH is a private hospital, 190-bed teaching hospital that medical students, nurses, and pharmacists train in and serves as a referral hospital for the country.

3.3 Population of the study :

Inclusion criteria :

Patient over 18 years old, admitted to the hospital and stay at least 24 hours, receiving at least one or more of restricted antimicrobial drugs.

Exclusion criteria:

Patient less than 18 years old, discharge from the hospital within less than 24 hours, not receiving restricted antimicrobial drugs

3.4 Sample size :

All the patients admitted to the hospital during one month from May, 1, 2024 to June, 1, 2024

3.4 Data collection :

This data was collected form the patient file, laboratory result and asked the nursing, the patient information was including gender, age, department and if in medical word or surgery. And lab result was including serum creatinine, whereas in antimicrobial we collate date, name in brand and generic, dose,

frequency, reconstitution, dilution and infusion rate. the collection data form found in Appendix A

3.6 Data analysis :

The data was add to excel then entry to SPSS 25 Software International Business Machines IBM to analysis. Where frequency and % was used.

3.7 Ethical Approve :

This study was approved by Emirate International University and USTH and the formal approve found in appendix B

CHAPTER IV

RESULT

Results

4.1 Demographic data

A total of 142 patients were included in our study. The proportion of male patients was higher than female [84 (59.2%) vs 58 (40.8%)]. Most of patients was elderly age more than 60 years old [52(36.6%)]. The patients were included from various hospital departments, such as Intensive Care Units (ICU), General Medical Male Ward, General Medical Female Ward, General Surgical Male Ward, General Surgical Female Ward, Private Male Ward, and Private Female Ward while the largest proportion of patients was in The ICU [63 (44.4%)]. There were high percentage of patients who were included in our study had renal impairment [58(40.8%)], DM, and HTN; while HTN patients most of them had controlled BP. The majority of patients were on 1 to 2 restricted antimicrobial [70 (49.3%), 53(37.3%)] respectively. Table 1.

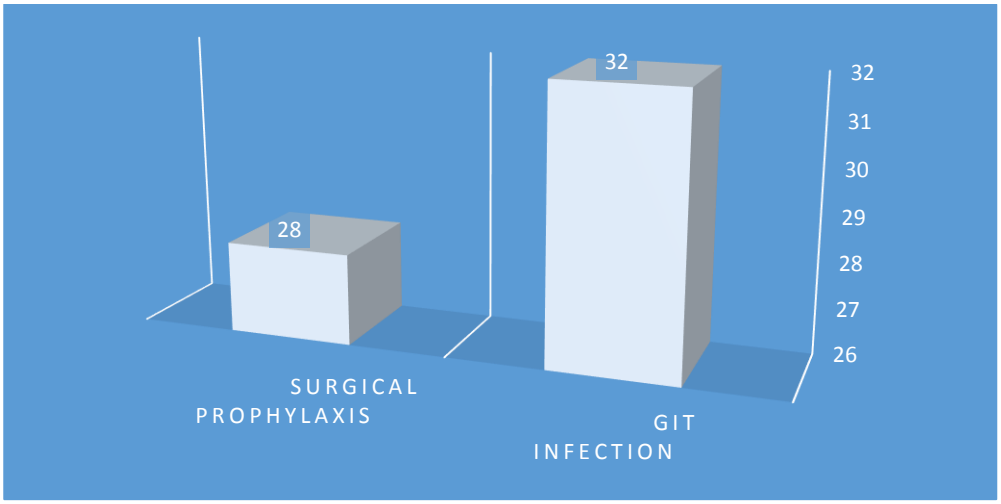
Table 1 Sociodemographic and clinical characteristics of included patients (n =142)

Parameters	frequently	Percent%
Gender		
Male	84	59.2%
Female	58	40.8%
Age category	***142***	
18-25 years	10	7.0%
26-45 years	34	23.9%
46-60 years	45	32.7%
>60 years	52	36.6%
Department	***141***	
General male ward	14	9.9%
General female ward	16	11.2%

Private male ward	29	20.4%
Private female ward	20	14.1%
ICU	63	44.4%
Specialty	142	
Medical	113	79.6%
Surgical	29	20.4%
Bp category	***142***	
≤120	87	61.3%
120 – 139	32	22.5%
140 -159	16	11.3%
≥160	7	4.9%
Scr category	***142***	
Normal	73	51.4%
High	58	40.8%
Comorbidities	***131***	
DM	40	28.2%
HTN	37	26.1%
AKI	30	21.2%
CKD	28	19.6%
ICVA	8	5.6%
IHD	8	5.6%
COPD	7	4.9%
CLD	7	4.9%
Concurrent restricted antimicrobial/patient		
1	70	49.3%
2	53	37.3%
3	14	9.9%
4	3	2.1%
5	1	0.7%

As seen in Fig1, the most indications for restricted antimicrobial were Gastrointestinal infections and Surgical Prophylaxis [32(22.3%) , 28(19.5%)] respectively.

Figure1 indication of prescribed restricted antimicrobial drug

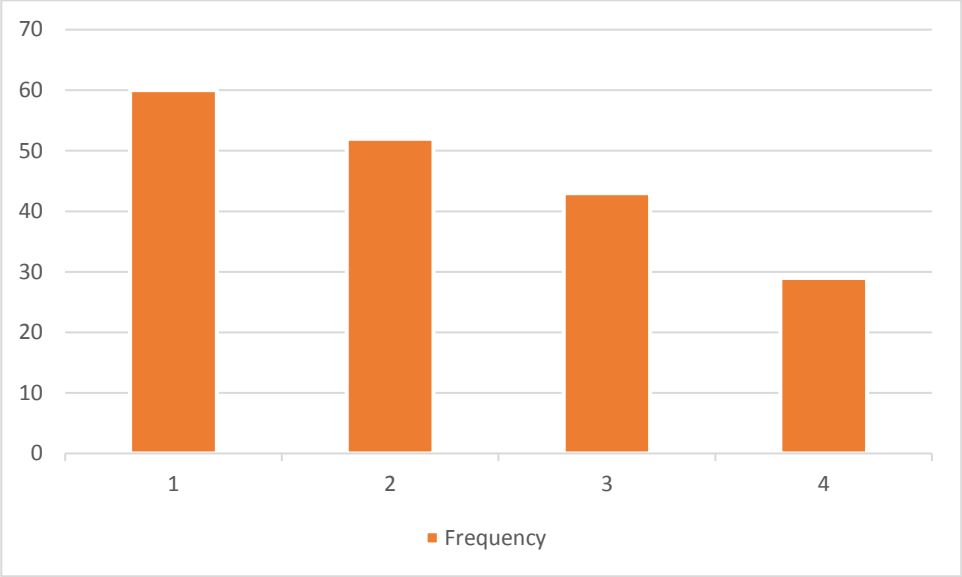


In Table2, The most prescribed restricted antimicrobials were Meropenem [42(26.5%)], Ciprofloxacin[37(23.4%)], Vancomycin[27(17.8%)], Levofloxacin[25(16.1%)], Piperacillin/Tazobactam[24(15.1%)]. The linezolid and colistin were the lowest prescribed agents in USTH departments.

Table 2 freqancy. of prescribed Restricted antimicrobials

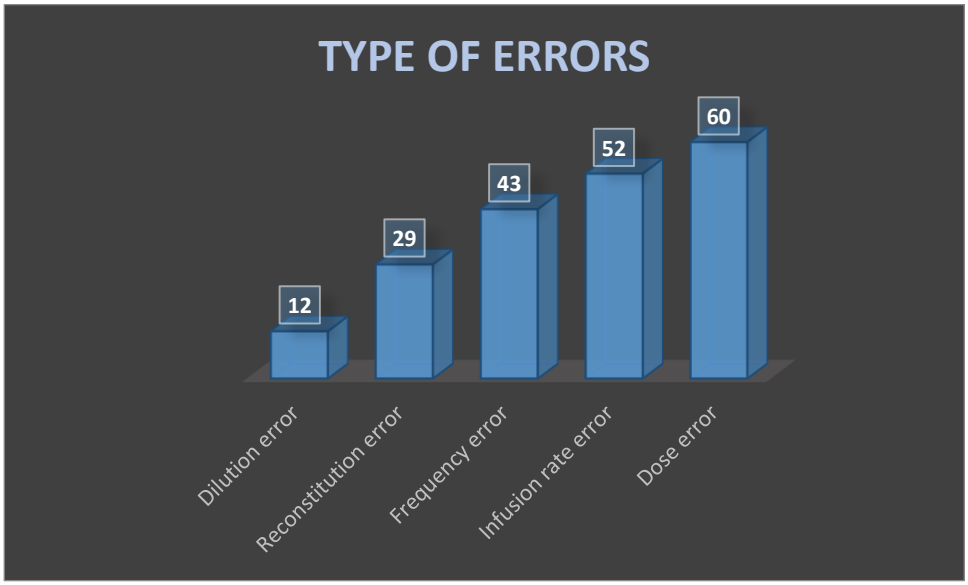
Parameters	Number
Meropenem	42
Ciprofloxacin	37
Vancomycin	27
Levofloxacin	25
Piperacillin/Tazobactam	24
Linezolid	2
Colistin	1

Figure2 frequency. of medication errors in restricted antimicrobial drugs



In Fig 2. The majority of patients who were included in our study had at least one medication error [56(39.4%)] or two medications errors [31(21.8%)]. And most of the medication errors were in dose [60(42.2%)], infusion rate [52(36.7%)], frequency [43(30.2%)] as in figure 3.

Figure 3 type medication error frequency



As seen in table 3, the type of medication errors with each restricted antimicrobial was mentioned. As well as, the example of errors and their correction. The medication errors were encounter mostly for Ciprofloxacin(50), Meropenem(45), Piperacillin/Tazobactam(26). For Ciprofloxacin the results showed that the most common error was in dose [32/50 (64%)], while Meropenem was in frequency error [20/45 (44%)]. For Piperacillin/Tazobactam the most common error was in infusion rate error [9/26 (34%)]. The dose error was the most common seen error in Fluconazole.

Table 3 medications, type of medication errors and their number *Description* and *correction*

Medication	Type of error	Number of Errors	Percent %	Description of error	correction
Ciprofloxacin	Dose Error	32	32/50	Given in lower dose 200mg instead of 400mg	Dose of ciprofloxacin 400mg
	Infusion Rate Error	16	16/50	Given in high infusion rate (10-30) min instead of 60 min	Infusion rate of ciprofloxacin is over 60 min
	Frequency Error	2	2/50	Given three daily / given once instead of twice daily	Frequency of ciprofloxacin twice daily
Meropenem	Frequency Error	20	13/45	Given three in dose 500mg instead of four / given twice in dose (1-2) g instead of three daily.	Frequency of Meropenem is500mg four times daily 1-2 g three times daily
	Reconstitution Error	16	16/45	Reconstitute in 10ml in dose 1g instead of 20ml	Reconstitute of meropenem 500mg in 10ml1g in 20ml
	Dose error	8	8/45	Given in dose 500mg every 8 hours in renal impairment patient	Dose should adjust up on the crcl 26-50ml/min every 12hr 10-25ml/min 250mg every 12hr <10ml/min 250 every 24hr
	Infusion Rate Eror	1	1/45	Given in high infusion rate 5min instead of (15-30) min	Infusion rate of meropenem is (15-30)
Piperacillin/Tazobactam	Infusion Rate Error	9	9/26	Given in high infusion rate (10-15) min instead of over 30 min	Infusion rate of Piperacillin/Tazobactam is over 30 min
	Dose error	7	7/26	Geven in 4.5g in renal Impairment patients instead of 2.25g	In renal impairment patients dose should adjust 2.25g every 8hr.
	Reconstitution Error	7	7/26	Reconstitute in 10 ml in dose 4.5g instead of (50-150) ml	Reconstitution of Piperacillin/Tazobactam 2.25g in 15ml 4.5g in 50-150ml
	Frequency Error	3	3/26	Given twice instead of three or four times daily	Frequency of Piperacillin/Tazobactam is three or four times daily

Medication	Type of error	Number of Errors	Percent %	Description of error	correction
Fluconazole	Dose Error	9	9/16	Given in low dose 200mg instead of 400mg	Dose of Fluconazole is 800mg loading dose then 400mg once daily
	Infusion Rate Error	7	7/16	Given in infusion rate 200mg in less than 60min	Infusion rate of Fluconazole is 200mg in 60min
Vancomycin	Dilution Error	7	7/16	Dilute in less than 5mg/ml dilute 1g in 100ml instead of 200ml	Dilution of vancomycin is 5mg/ml 500mg in 100ml 1g in 200ml
	Reconstitution Error	7	7/16	Reconstitute in less than 50mg/ml 1g in 10ml instead of 20ml	Reconstitution of vancomycin is 50mg/ml 500m in 10ml 1g in 20ml
	Dose Error	1	1/16	Given in lower dose than 750mg give 500mg instead of 1g or 750mg in renal impairment patients.	Dose of vancomycin is from 1g to 2g In renal impairment 750mg every 24hr
	Infusion Rate Error	1	1/16	Given in infusion rate less than 30 min infused in 15min instead of 30min	Infusion rate of vancomycin is from 30 to 60min.
Amikacin	Frequency Error	5	5/12	Given in once in dose 500mg instead of three times daily	Frequency of Amikacin is if dose 400-500mg three daily/1-1.5g once daily
	Dilution Error	5	5/12	Dilute in less than 0.25-5mg/ml 1g diluted in 100ml instead of 200ml	Dilution of Amikacin if dos 0.25-5mg/ml 500mg/100ml 1g/200ml
	Infusion Rate Error	2	2/12	Given in infusion rate 15-20 min instead of 30-60 min	Infusion rate of Amikacin is 30-60min
Levofloxacin	Infusion Rate Error	7	7/9	Given in high infusion rate (10-30) min instead of 60 min	Infusion rate of levofloxacin is over 60 min
	Dose Error	1	1/9	Given in lower dose 500mg instead of 750mg	Dose of levofloxacin in LRTI is 750mg
	Frequency Error	1	1/9	Given twice instead of once daily	Frequency of levofloxacin is once daily
Imipenem/Cilastatin	Frequency Error	4	4/6	Given three daily in dose 500mg instead of four / given twice in dose 1g	Frequency of Imipenem/cilastatin 500mg four daily 1g three daily
	Infusion Rate Error	2	2/6	Given in infusion rate less than 20 min in dose <500mg /given in infusion rate less than 40min in dose >500mg 1g given in 20 min instead of 40min	Infusion rate of Imipenem/cilastatin <500mg 20min >500mg 40-60min
Cefepime	Infusion Rate Error	4	4/6	Given in high infusion rate 15 min instead of 30 min	Infusion rate of cefepime 30min
	Frequency Error	2	1/6	Geven in dose 1g every 12 hour in renal impairment patients instead of every 24 hour	Cefepime give in initial dose (500mg-2g) every 24 hour in renal impairment patients

Medication	Type of error	Number of Errors	Percent %	Description of error	correction
Gentamycin	Frequency Error	3	3/3	Given in twice daily in dose 80mg instead of three times daily	Frequency rate of Gentamycin is 3-5mg/kg every 8hours 240mg in three divided doses
Ceftazidime	Frequency Error	1	1/4	Given once instead of twice	Freq of ceftazidime three times daily
	Infusion Rate Error	1	1/4	Given in high infusion rate (10-15) min instead of over 30 min	Infusion rate of ceftazidime over 30 min
	Dose error	2	2/4	Geven in 1g every 12 hour in patients with renal impairment without of dose adjustment	Ceftazidime should dose adjustment in in patients with renal impairment up on crcl.
Moxifloxacin	Frequency Error	1	1/2	Given twice instead of once daily	Frequency of Moxifloxacin once daily
	Infusion Rate Error	1	1/2	Given in high infusion rate (10-30) min instead of 60 min	Infusion rate of moxifloxacin is over 60 min

CHAPTER V

DISCUSSION

5.1 Discussion

The study focused on the identification of medication administration errors of restricted antimicrobial drugs and their doses and frequencies. The most important findings were:

1) The surgical prophylaxis was one of the most common indication of prescribed restricted antimicrobial .
2) Dose error, Infusion rate error and frequency error were the most common medication administration errors.
3) Ciprofloxacin , Meropenem, and Piperacillin/Tazobactam the most common antimicrobial agents had medication administration errors.

In our study one of the most indication for restricted antimicrobials agents was surgical prophylaxis. However, in another study that was conducted in Croatia found restricted antimicrobial was prescribed mostly for chest infection and not for surgical prophylaxis.[26] The prescribing of restricted antimicrobial agents for surgical prophylaxis in our study maybe due to inexistence of standard policy for surgical prophylaxis and a faired of surgical physicians from surgical site infections which made them to prescribe strong antibiotics as prophylaxis.

Dose error, infusion rate error and frequency error were from the most common medication administration errors. In consistence with our study, infusion rate and frequency were from the major or most common medication errors in study conducted in Jordan. However, the dosing error was not common as our study.[27] The differences among results may be due to unavailability of doses and frequence protocols policy, using normal saline as standard solution

for reconstitution may be due to shortage of sterile distal water (SWFI), and existence of dosage forms with lower strength than recommended doses such as ciprofloxacin only available in 200 mg IV solution, where recommended dose is 400 mg.

The most common medications errors with ciprofloxacin was in dose errors, as mentioned above, this is error may be due to unavailability of dosage form of IV solution of ciprofloxacin with stander dose that may affecting physician prescribing behavior and made them to prescribe more convention dose to the patient (i.e. one vail/dose instead of two vials/dose) which also will be less costly for the patient. Morevere, physician maybe unaware about the correct dose for Ciprofloxacin which needs more efforts to increase awareness through continues educational activity regarding medication errors.

Meropenem administration error was reconstitution error this error may be due to less knowledge of nurse about how to reconstitute it. The practitioners reconstitute all the medications in 10 ml of normal saline without referring to the references about the optimal reconstitutions or ask the pharmacist about this idea. In additional to, shortage of SWFI in the wards of hospital and pharmacy.

Piperacillin/Tazobactam found to be administered through 15 min instead of 30 mins. These maybe due to similar reasons as above such as lack knowledge, unavailability of infusion rate pumps for all patients which made accurate infusion rate of medications is impossible. Moreover, poor communications between nurses and pharmacist which made the seeking for right information is not easy to afford due to heavy workload and time limitations.

5.2 Limitations of study:

While this is study gave us valuable information regarding administration, dose, frequency errors, there are some limiting such as, only study restricted antimicrobial rather than all medications, and the study conducted in one center.

CHAPTER VI

CONCLUSION AND RECOMMENDATIONS

Conclusion

6.1 Conclusion:

In conclusion, the findings of this study emphasize the importance of addressing the identified issues through targeted education, technology-enabled support, and comprehensive antimicrobial stewardship programs to ensure the safe and appropriate use and administration of restricted antimicrobial drugs in the clinical setting.

6.2 Recommendations

Based on the discussion and findings from the study, the following recommendations are proposed:

- Provide specialized training programs for older nursing staff on evolving clinical practices and technologies related to restricted antimicrobial drugs.
- Implement comprehensive training and monitoring programs to address medication errors (dose, frequency, infusion rate, reconstitution and dilution errors).
- Explore the use of smart infusion pumps and computerized prescriber order entry (CPOE) systems to support accurate drug administration and reduce errors.
- Integrate decision support tools within technology-based solutions to guide appropriate dosing, administration, and monitoring of restricted antimicrobial drugs.

- Encourage combination therapy and de-escalation strategies to optimize antimicrobial therapy and improve patient outcomes.

- Implement comprehensive antimicrobial stewardship programs focused on appropriate selection, dosing, and duration of restricted antimicrobial drugs.

- Emphasize careful patient assessment and monitoring to guide appropriate dosing and prevent adverse events.

- Develop protocols and decision support tools to facilitate timely dose adjustments based on patient-specific factors.

- Provide comprehensive training and ongoing monitoring to ensure adherence to proper aseptic techniques during reconstitution and dilution of restricted antimicrobial drugs.

- Implement quality assurance measures, such as regular audits and feedback, to reinforce the importance of aseptic practices.

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APPENDIX

Appendix (A)

DATA COLLECTION FORM (DCF)

Inppropriateness of Dosing & IV Fluid of Restricted Antimicrobial Therapies Patients at Referral Healthcare Center in Sana'a City, Yemen

Patient initials: ☐ ☐ ☐ ☐

Research ID: ☐ ☐ ☐

patient Hospital ID: ☐

Hospital name: ☐

INCLUSION CRITERIA

DESCRIPTION	YES	NO
1. Patient with age 18 years old and more		
2. Patient receive at least one or more of restricted antimicrobial		
3. Admitted to hospital & stay at least 24 hours		

*If the answer to any of the questions in the Inclusion Criteria is **NO**, the subject must be excluded from the study.*

EXCLUSION CRITERIA

DESCRIPTION	YES	NO
1. Patient with age <18 years old		
2. patient not receiving any restricted antimicrobial		
3. patient discharge from hospital within less than 24 hours		

*If the answer to any of the questions in the Exclusion Criteria is **YES**, the subject must be excluded from the study.*

❖ **Patient Details:**

Gender: ☐ M ☐ F	Age:
Height: cm, weight: kg, BMI:	Date of Admission:
Date of collecting data:	Department;
Vital signs: BP: pulse: Temp: RR: O2:	Primary Physician Specialty: ICU , Surgical , medical , nuro , cardio
Indications of Restricted Antimicrobial:	

Comorbidities ;

Comorbidities	Duration	Note

LABORATORY VALUES

Date									Normal ring
CrCl									
S.Cr									

Date of prescribe	Name of antibiotic	Brand name	Dose	Route	Freq	Stop Use

Generic Name	Brand name	Dose Strength	Dosage Form	Reconstitution		Dilution		Infusion Rate	Comment
				Type	Amount	Type	Amount		

Appendix (B)

Republic of Yemen
Emirates International University
College of Medicine & Health Sciences

الجمهورية اليمنية
الجامعة الإماراتية الدولية
كلية الطب و العلوم الصحية

EMIRATES INTERNATIONAL UNIVERSITY

الأخ الدكتور / مدير مستشفى جامعة العلوم والتكنولوجيا المحترم

تحية طيبة وبعد ،،

الموضوع/ السماح لطلاب الصيدلة السريرية(Pharm-D) المستوى السادس لجمع بيانات بحث التخرج

تهديكم الجامعة الإماراتية الدولية اطيب تحياتها متمنية لكم دوام التوفيق والنجاح في اعمالكم .

بالإشارة الى الموضوع أعلاه فأننا نرجو من سيادتكم التكرم بالتوجيه لمن يلزم بالسماح لطلاب المستوى السادس -صيدلة سريرية (Pharm-D) لدخول لمشفاكم حتى يتسنى للطلاب أخذ البيانات المطلوبة لخدمة بحث تخرجهم والذي سيحمل عنوان

Appropriate Dose and I.V fluid of restricted antimicrobial drugs

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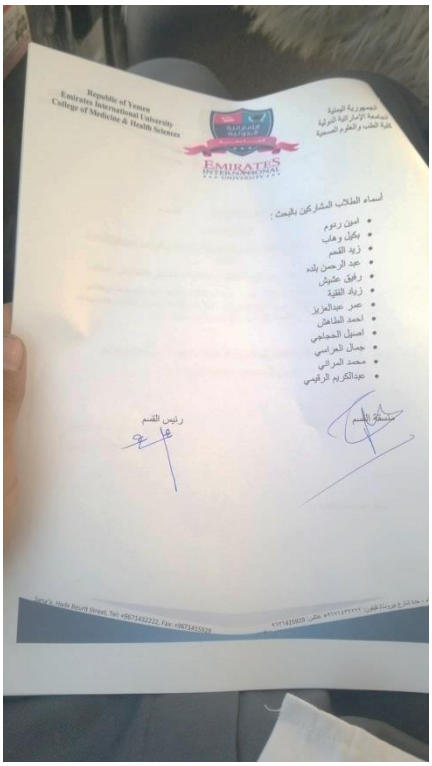

Republic of Yemen
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الجمهورية اليمنية
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كلية الطب و العلوم الصحية

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- بكيل وهاب
- زيد القدس
- عبد الرحمن بلده
- رفيق عقيل
- زياد القبلة
- عمر عبدالعزيز
- احمد الشاهل
- اصيل الحجاجي
- جمال المرانسي
- محمد المرالي
- عبدالكريم الرقيبي

رئيس القسم

مستشفى جامعة العلوم والتكنولوجيا
إدارة الموارد البشرية – قسم التدريب

التاريخ :

نموذج موافقة جمع بيانات بحث علمي

اسم الباحث: الشهادة: الجامعة : الإماراتية الدولية

عنوان البحث

Appropriateness of dose and I.V fluid administration of restricted antimicrobial drugs

موافقة الإدارة والقسم المعني بجمع البيانات:

القسم: الإدارة:

تم الاطلاع على عنوان البحث وأداة جمع البيانات ونوافق على جمع البيانات

رئيس القسم	مدير الإدارة
الاسم:	الاسم:
التوقيع:	التوقيع:

موافقة إدارة الجودة

تم الاطلاع على عنوان البحث وأداة جمع البيانات ونوافق على جمع البيانات

الاسم

التوقيع

اعتماد المدير العام أو المدير الطبي

الخلاصة

المقدمة:

يعد الاستخدام غير المناسب للأدوية المضادة للميكروبات وإدارتها ، لا سيما تلك المصنفة على أنها أدوية مقيدة ، مساهما رئيسيا في الأخطاء الدوائية وإلحاق الضرر بالمريض. تهدف هذه الدراسة إلى تحديد أنواع وانتشار وحدوث هذه الأخطاء الدوائية.

الطرق:

تم إجراء دراسة مقطعية في جامعة العلوم والتكنولوجيا في صنعاء، اليمن، خلال شهر واحد من 1 مايو 2024 إلى 1 يونيو 2024، شملت جميع المرضى الذين تم إدخالهم إلى المستشفى بما في ذلك البالغين. المرضى الذين تم إدخالهم إلى المستشفى وبقوا لمدة لا تقل عن 24 ساعة، يتلقون واحدًا أو أكثر من الأدوية المضادة للميكروبات المقيدة. تم جمع هذه البيانات من ملف المريض، نتائج المختبر، وسؤال الممرضين. كانت المعلومات المتعلقة بالمريض تشمل الجنس، العمر، القسم، وما إذا كان في قسم الباطنية أو الجراحة. كانت نتيجة التحليل تشمل مستوى الكرياتينين ، بينما في مضادات الميكروبات نجمع البيانات، الاسم التجاري والعلمي، الجرعة، التكرار، إعادة التكوين، التخفيف ومعدل التسريب. .

النتائج:

وقد أُدرج في دراستنا ما مجموعه 142 مريضا . وكان المرضى من مختلف أقسام المستشفى، في حين كانت النسبة الأكبر من المرضى في وحدة العناية المركزة 63 (44.4 %).وكانت هناك نسبة مئوية عالية من المرضى الذين أُدرجوا في دراستنا مصابين بإعاقة كلوية 58 (40.8 %). وكانت غالبية المرضى على 1 إلى 2 مضادات للميكروبات المقيدة [70(49.3 %) و53 (37.3 %) على التوالي. وكانت معظم المؤشرات على تقييد مضادات الميكروبات هي التهابات الجهاز الهضمي المعوي والوقاية الجراحية (32(22.3 %) و28(19.5 %) على التوالي. كانت المضادات الميكروبيه المقيده الاكثر وصفا هي ميروبينيم 42 (26.5%) , و سيبروفلوكساسين 37 (23.4%) . اللينيزولايد والكولستين كانوا المضادات الأقل وصفا في اقسام مستشفى جامعة العلوم والتكنولوجيا. غالبية المرضى الذين أُدرجوا في دراستنا كان لديهم على الأقل خطأ طبي واحد 56 (39.4%) او اثنين اخطاء 31 (21.8) . أكثر الأخطاء الطبية

كانت في الجرعة 60 (42.2) و تسريب خاطئ 52 (36.7%) و التكرار 43 (30.2%). نوع الاخطاء الطبية التي تم التركيز عليها لكل مضاد ميكروبي مقيد. بالأضافة الى امثلة للأخطاء وتعديلها. كانت الأخطاء الدوائية تصادف في الغالب السيبروفلوكساسين (50) و الميروبينيم (45) وبيبيراسللين \ تازوباكتام (26). في السيبروفلوكساسين الخطأ الدوائي الأكثر كان في الجرعة 32 (64%) في حين كان خطأ التكرار الأكثر في الميروبينيم 20 (44%). بالنسبة للبيبيراسيللين \ تازوباكتام كان الخطأ الأكثرشيوع في معدل التسريب 9 (34%). معدل التريب الخاطئ كان الأكثر شيوعا في الفلوكونازول.

الأستنتاج :

تسلط هذه الدراسة الضوء على مدى أهمية مواجهة التحديات الموجودة من أجل ضمان الإدارة الآمنة والمناسبة للأدوية المضادة للميكروبات المقيدة. وتشمل هذه التدابير التعليم المستهدف، والمساعدة القائمة على التكنولوجيا، وبرامج الإشراف الكاملة على مضادات الميكروبات. .

الجمهورية اليمنية
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الجامعة الإماراتية الدولية
كلية الطب والعلوم الصحية
قسم الصيدلة السريرية (دكتور صيدلي)

عدم ملائمة الجرعات والإعطاء الوريدي للأدوية المضادة للميكروبات المقيدة

مشروع بحث تخرج مقدم لاستكمال الحصول على درجة البكالوريوس من قسم الصيدلة السريرية (دكتور صيدلي)

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2024 - 1446