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Assessment of clinical pharmacist interventions using a web-based application in a Saudi Arabian Tertiary Hospital

Rana Omar AlKhanbashi[1], Yahya AlNoamy[2], Reham Ghandorah[2], Razan Mohammed Awan[2] and Hala AlButi[2]

Abstract

Objectives: Medication-related problems are a top concern of clinical pharmacists. Medication-related problems can cause patient harm and increase the number of visits, hospital admissions, and length of hospital stay. The objective was to assess clinical pharmacy medication-related problem-related interventions in a tertiary care setting.

Methods: A retrospective cohort study was conducted at King Fahad Armed Forces Hospital in Jeddah (Saudi Arabia) between June 2021 and June 2022. The data were extracted monthly from a new web-based Microsoft Excel application documenting medication-related problems during any stage of the medication use process.

Results: A total of 5310 medication-related problem-related interventions in 1494 patients were performed. The departments associated with the highest frequency of medication-related problem-related interventions were the critical care unit (26.9%), intensive care unit (23.8%), anticoagulation clinic (17.1%), medical ward (11.3%), and nephrology unit (6.8%). The most common type of medication-related problem-related interventions included inappropriate dosage regimens (25.6%), monitoring drug effect or therapeutic drug monitoring (24.4%), requirement of additional drug therapy (21.9%), and inappropriate drug selection (14.1%). The proposed interventions were accepted by physicians in 97% of the incidents. The most frequent medication classes associated with medication-related problem-related interventions were cardiovascular agents (47.6%), antimicrobial agents (27.2%), and nutrition and blood substitute agents (11.4%). The most frequent medication groups associated with medication-related problem-related interventions were anticoagulants (25.6%) and antibiotics (25.2%).

Conclusions: The current findings characterize the medication-related problem-related interventions addressed in clinical pharmacy at a tertiary care setting. The high rate of physician acceptance emphasizes the integral patient safety role of clinical pharmacy services.

Keywords

Clinical pharmacy, interventions, web-based application, medication-related problems, hospital pharmacy, Saudi Arabia

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Introduction

Medication-related problems (MRPs) are a top concern of clinical pharmacists.[1] MRPs are a circumstance or event involving drug therapy that actually or potentially interferes with the desired health outcomes.[2] There are eight types of MRPs acknowledged by the American Society of Health-System Pharmacists.[1] They include adverse drug reactions (side effects), drug interactions, drug use without an indication, failure to receive medications, improper drug selection, and untreated indications.[1] They can occur when prescribing, dispensing, or administering medicines.[3] They can occur in both inpatient and outpatient settings as well as transition of care from primary care to hospital or the reverse.[4,5]

[1]Department of Pharmaceutical Services, Pharmacy Quality Services, King Fahad Armed Forces Hospital, Jeddah, Saudi Arabia
[2]Department of Pharmaceutical Services, Pharmacy Clinical Services, King Fahad Armed Forces Hospital, Jeddah, Saudi Arabia

Corresponding author:
Rana Omar AlKhanbashi, King Fahad Armed Forces Hospital, Corniche Road, Al Andalus, P.O. Box 9862, Jeddah 21159, Saudi Arabia.
Email: R.Alkhanbashi60@gmail.com

It is essential to detect and treat MRPs to ensure that patients attain their therapeutic goals and achieve optimal drug therapy outcomes.[1,6] MRPs are often due to certain patients' medication-related issues not being identified and documented, which can lead to clinical complications. MRPs can also increase the number of clinic visits, hospital admissions, or the length of hospital stay.[7–9] In addition, they can increase the risk of side effects, antimicrobial resistance, and the cost of treatment.[7] Approximately 1%–5% of MRPs can cause patient harm or drug adverse events.[4,10] However, up to 80% of MRPs can be prevented with the aid of clinical pharmacists.[11] Virtual pharmacist interventions can help reduce the abuse/misuse of over-the-counter medications, especially with the current high acceptance of telemedicine services after COVID-19.[12,13]

Clinical pharmacists play a critical role in helping identify, treat, and prevent MRPs through specific interventions.[14] Therefore, pharmacists contribute to improving patient safety and the quality of medication use.[15] The Royal Pharmaceutical Society of Great Britain recommended recording the intervention in the medication records of patients or on separate forms either electronically or manually in places where these medication records had not existed.[16] In addition, artificial intelligence can further improve pharmacist interventions for hospital and community medications.[17] In Saudi Arabia, approximately half of all pharmacist documentations are performed electronically. MRPs-related clinical pharmacist interventions have been studied in Saudi Arabia in manually collected data.[18–20] The objective of the current study was to assess MRPs-related clinical pharmacist interventions collected using a new web-based application in a tertiary care setting. In addition, characterizing the most common types and classes of medications is associated with MRPs-related clinical pharmacist interventions.

Methods

Study design: A retrospective cohort study was conducted from June 2021 to June 2022 at King Fahad Armed Forces Hospital (KFAFH) in Jeddah, Saudi Arabia.

Setting: KFAFH is a 530-bed tertiary care hospital that provides primary, secondary, and tertiary types of care, with a pharmacy department comprising 220 pharmacists, clinical pharmacists, and pharmacist technicians. Since 2017, KFAFH has been accredited locally by the Saudi Central Board for Accreditation of Healthcare Institutions and internationally by the Joint Commission International.

Population: All MRPs-related clinical pharmacist interventions between June 2021 and June 2022 among patients in 10 inpatient units and 3 outpatient clinics. These units are all the units covered by clinical pharmacy services. Inpatient units covered included cardiac care unit (CCU), intensive care unit (ICU), pediatric intensive care unit, neonatal intensive care unit, medical ward, surgical ward, pediatric ward, nephrology unit, renal transplant, and oncology/hematology. Outpatient clinics covered included anticoagulation clinics, integrated care clinics, and emergency departments. Special pharmacy services at the admission and discharge were not covered by clinician pharmacists and therefore were not included.

Sample size: To be able to examine the MRPs-related clinical pharmacist interventions for individual medications with administration frequency as low as 3% with 0.5% confidence and 95% significance level, 4452 interventions would be required. It was estimated that this number of interventions would require a year's worth of data collection. During the study, a total of 5310 MRPs-related clinical pharmacist interventions were performed.

Data collection: The data were collected using the web-based application in the hospital intranet system. All data were automatically exported in a monthly shared Excel data sheet to analyze the relation of clinical MRPs-related clinical pharmacist interventions with the following variables: hospital department in which the MRP occurred, type of MRP, and physicians' response to the intervention. The web-based application is a user-friendly application, as it employs a simple two-step method of documentation. In the first step, the pharmacist's identification step, the application only allows hospital-registered clinical pharmacists with recognized employee numbers, to gain access to the next step. The second step involves data collection in forms with lists and checkboxes. These included the patient's medical number (name and other identifying personal information omitted), patient care unit (ward), date of intervention, type of intervention, type of action taken, medication involved, physician acceptance, name of the physician, and any other information the pharmacist deemed important to include. Each step cannot be bypassed until all necessary information is entered.

Validation of data collection tool: Validity of the new web-based application in documenting MRPs was done by reviewing the variables collected and the process of documentation by experts in pharmacy and information technology. In addition, a pilot study was done with 30% of clinical pharmacists for a week to examine the logistic and convenience aspects of data collection through the new application.

Clinical pharmacy services: It consisted of 13 clinical pharmacists who provided a wide range of clinical services and managerial responsibilities. They covered 530 beds (one clinical pharmacist to 40 beds). The clinical pharmacist's duty is to attend the daily rounds with their assigned medical team and provide pharmaceutical assistance and education to their respective ward and students. All clinical pharmacists have a PharmD or MSc degree in clinical pharmacy.

Interventions: Any clinical pharmacist's action that affects the patient's care in any aspect is considered an intervention. It can occur during any stage of the patient's care process between admission and discharge. Each clinical pharmacist documents their daily interventions during their daily working hours, which are typically from 7:30 am to

Table 1. Clinical pharmacist interventions related to medication-related problems by hospital units included ($N = 5310$).

Unit	Number	Percentage (%)
Intensive care units	2897	54.6
Cardiac care unit	1429	26.9
Intensive care unit	1266	23.8
Pediatric intensive care unit	104	2.0
Neonatal intensive care unit	98	1.8
Inpatient wards	1485	28.2
Medical ward	603	11.3
Nephrology unit	360	6.8
Renal transplant	319	6.0
Oncology/hematology	104	2.0
Surgical ward	68	1.3
Pediatric ward	31	0.6
Outpatients	928	17.5
Anticoagulation clinic	907	17.1
Other outpatients	21	0.4

Table 2. Types of clinical pharmacist interventions related to medication-related problems ($N = 5310$).

Type of intervention	Number	Percentage (%)
Inappropriate dosage regimen	1358	25.6
Monitoring drug effect/therapeutic drug monitoring	1294	24.4
Require additional drug therapy	1161	21.9
Inappropriate drug selection	748	14.1
Providing information to healthcare providers	411	7.7
Adverse drug reaction	338	6.4

4:30 pm. The interventions are documented in the web-based application using the hospital's intranet system. Inappropriate dosage regimen included any wrong dose, frequency, route, and dose adjustment. Inappropriate drug selection included any stop medication, unnecessary drug therapy, and de-escalation. Adverse drug reactions include any drug allergies, side effects, or drug interactions. Requiring additional drug therapy included optimizing drug therapy. Lastly, monitoring drug effects involves therapeutic drug monitoring (TDM).

Data analysis: Data were presented as frequencies and percentages. The associations between physician acceptance of MRPs-related clinical pharmacist interventions and the type of these interventions were examined using chi-square or Fisher's exact test, as appropriate. p-value < 0.05 was considered significant. SPSS (Version 25.0. Armonk, NY: IBM Corp) was used for all statistical analyses.

Ethical approval: Ethical approval for the research project was obtained from the Research Ethics Committee of the King Fahad Armed Forces Hospital-Jeddah (REC 513, 21/Jun/2022).

Informed consent: The patient consent had been waived by the Research Ethics Committee of the King Fahad Armed Forces Hospital-Jeddah because the study design ensures data collection of routine patient care. In addition, the research poses no more than minimal risk to included patients and will not adversely affect the rights and welfare of the included patients.

Results

During the study, 5310 MRPs-related clinical pharmacist interventions were performed at KFAFH. A total of 1494 patients were involved in these interventions (including 528 unique patients and 966 duplicated patients). As shown in Table 1, the majority of MRPs happened in ICUs (54.6%), followed by wards (28.2%) and lastly outpatient clinics (17.5%). The departments associated with the highest frequency of MRPs-related interventions were the CCU (26.9%), ICU (23.8%), anticoagulation clinic (17.1%), medical ward (11.3%), and nephrology unit (6.8%).

As shown in Table 2, the most common type of MRP interventions included inappropriate dosage regimens (25.6%), monitoring drug effect or TDM (24.4%), requirement of additional drug therapy (21.9%), and inappropriate drug selection (14.1%). As shown in Figure 1, the proposed MRPs-related clinical pharmacist interventions were accepted by physicians in 97% of the incidents.

As shown in Table 3, cardiovascular agents were the class of medications most often associated with MRPs-related

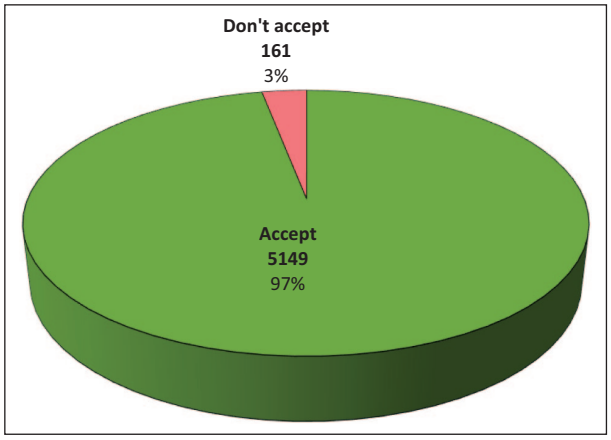

Figure 1. Physician acceptance of the clinical pharmacist interventions related to medication-related problems ($N = 5310$).

Table 3. Medications class involved in clinical pharmacist interventions related to medication-related problems ($N = 5310$).

Medication class	Number	Percentage (%)
Cardiovascular agents	2530	47.6
Anticoagulants	1362	25.6
Antihypertensive	467	8.8
Diuretics	291	5.5
Antilipemic	205	3.9
Antiplatelets	85	1.6
Antiarrhythmic	38	0.7
Anti-heart failure	28	0.5
Antianginal	27	0.5
Inotrope	10	0.2
Vasopressin	10	0.2
Vasodilators	3	0.1
Thrombolytic	2	0.0
Alpha 1 blocker	1	0.02
Capillary-stabilizing agent	1	0.02
Antimicrobial agents	1443	27.2
Antibiotics	1336	25.2
Antiviral	64	1.2
Antifungal	43	0.8
Nutrition and blood substitute agents	603	11.4
Electrolyte supplement	352	6.6
Vitamins/supplements	88	1.7
Phosphate binder	67	1.3
Hematopoietic	49	0.9
Blood product derivative	28	0.5
Antihemophilic	10	0.2
Iron exchange resin	9	0.2
Endocrine system agents	211	4.0
Antidiabetic	119	2.2
Corticosteroid	77	1.5
Calcimimetic	8	0.2
Thyroid product	3	0.1
5-alpha reductase inhibitor	2	0.04
Hormonal	2	0.04
Central nervous system agents	185	3.5
Antiseizure	75	1.4
Analgesics	47	0.9
Antipsychotic	28	0.5
Antihistamine	25	0.5
Antiparkinson	6	0.1
Dopamine receptor agonists	3	0.1
Serotonin and histamine antagonists	1	0.02
Gastrointestinal agents	166	3.1
Ulcer healing agent	123	2.3
Laxatives	36	0.7
Antidiarrheal	4	0.1
Antispasmodics	2	0.0
Antiemetic	1	0.02
Malignant disease and immunosuppressant agents	61	1.1
Immunosuppressants	39	0.7
Antineoplastic agent	20	0.4
Monoclonal antibodies	2	0.04
Musculoskeletal agents	41	0.8
Antigout	23	0.4
Neuromuscular blocker	9	0.2
Chelating agent	4	0.1
Skeletal muscle relaxant	3	0.1
Anticholinergic	2	0.04
Respiratory agents	22	0.4
Bronchodilators	12	0.2
Mucolytic	6	0.1
Antitussive	2	0.04
Decongestant	1	0.02
Antidote agents	10	0.2
Anesthetic agents	10	0.2
Ophthalmic agents	2	0.04

clinical pharmacist interventions (47.6%). This was followed by antimicrobial agents (27.2%) and nutrition and blood substitute agents (11.4%). The most frequent medication groups associated with MRPs-related clinical pharmacist interventions were anticoagulants (25.6%) and antibiotics (25.2%). Physician acceptance of MRPs-related clinical pharmacist interventions was significantly associated with monitoring drug effect/TDM ($p < 0.001$), inappropriate drug selection ($p < 0.001$), providing information to healthcare providers ($p = 0.011$), and adverse drug reaction ($p = 0.011$).

Discussion

Inappropriate medication usage is a significant public health concern that has a detrimental impact on treatment outcomes and raises the expense of managing MRPs. MRPs can lead to morbidities, hospital stays, and fatalities. In addition, MRPs may account for 5%–10% of hospital admissions, of which up to 60% are avoidable.[21] The clinical pharmacist usually

works as part of a multidisciplinary team to carry out pharmacotherapy interventions that improve the efficacy and safety of medication therapy.[22]

Our results showed that four types of ICUs were responsible for half of all MRPs-related clinical pharmacist interventions, followed by the anticoagulation clinic (17%). Previous studies showed that MRPs can occur in both inpatient and outpatient settings, with high incidence in ICU.[4,19,23] In Saudi Arabia tertiary hospital, the incidence of MRPs was highest in the pediatric ICU (59.7%).[19] While in children's hospitals, the incidence of MRPs was reported in pediatric wards (26.9%). The highest reported rate was in pediatric ICU (15.2%).[23] In the United States, 60% of MRPs occurred in inpatient locations and 40% occurred in outpatient locations.[4] Dosing problems were the most frequently reported MRPs (54%).[23] Polypharmacy and number of comorbidities were potential risk factors.[19,24] In addition, a higher risk of MRPs is expected during the transition of care such as from primary care to hospital or the reverse and transfer from one hospital/unit to another.[5,19]

The most common types of MRPs-related interventions in the current study were dosage problems, monitoring problems, requirement of additional drug therapy, and inappropriate drug selection. According to the American College of Clinical Pharmacy practice-based research network, more than half of MRPs were prescribing problems, followed by administering, monitoring, dispensing, and documenting problems.[4] In addition, drug–drug interactions represented one-third of all MRPs in a German University hospital.[25] In Saudi Arabia, dosing problems and drug choice problems were the most frequently reported MRPs among hospitalized pediatric patients.[6]

Three-fourths of all MRPs-related interventions in the current study were related to cardiovascular agents (48%) and antimicrobial agents (27%). A systematic review by Suggett et al.[26] concluded that intravenous antimicrobials, thrombolytic/anticoagulants, cardiovascular agents, central nervous system agents, corticosteroids, diuretics, chemotherapeutics, insulin/hypoglycemic, opiates, and anti-epileptics are the 10 most common drug classes associated with MRPs. In the United States, the most frequent medication classes associated with MRPs were systemic antimicrobials, hematologic, and cardiovascular medications.[4]

In 97% of incidents, medical staff in the current study accepted the proposed interventions. Similar to the current study, previous studies reported more than 90% prescriber acceptance for clinical pharmacist treatments in hospital settings.[24,27] However, lower acceptance (less than 50%) has been reported in primary care settings.[28,29] In Saudi Arabia, hospital-based acceptance of MRPs-related clinical pharmacist interventions ranged between 70% and 90%.[18–20] The high rate of acceptance is consistent with the integral role of clinical pharmacists in reducing drug-related patient harm[2,6] and potential drug interactions.[30]

Physician acceptance of MRPs-related clinical pharmacist interventions in the current study was significantly associated with monitoring drug effect/TDM, inappropriate drug selection, providing information to healthcare providers, and adverse drug reactions. In Saudi Arabia, physician acceptance of MRPs-related interventions in a tertiary setting was significantly associated with telephone-delivered interventions, medication overdosage, and major MRPs.[19] In the Netherlands, physician's acceptance of clinical pharmacists' intervention was inversely correlated with continuing pre-admission therapy and significantly associated with the number of prescription medicines and the severity of the drug-related problem.[31] Clinical factors such as diabetic status, statin use, and antiplatelet use were reliable predictors of the quantity of MRPs.[32]

The current study used a new web-based Microsoft Excel application for documenting MRPs. In a study done among Medicare beneficiaries in the United States, a web-based electronic health record system was found to be a very useful and efficient tool for assisting pharmacists in determining the appropriate and safe use of medication among elderly patients.[22] Electronic systems can help pharmacists in their intervention by convenient evaluation of the clinical diagnosis, laboratory results, and pharmacy data.[22,33]

The current study has several strengths: the large sample size, coverage of different patient settings, the use of a new web-based application, and inclusion of all consecutive MRPs over a year. Nevertheless, the single-center experience may limit the generalization of the results. Special pharmacy services at the admission and discharge were not examined. The influence of the characteristics of patient and clinical pharmacist on pharmacist interventions and physician acceptance was not examined, as these data are not collected by the application.

Conclusions

The current findings characterize the MRPs-related interventions addressed in clinical pharmacy at a tertiary care setting. Anticoagulants and antibiotics were responsible for half of all MRPs-related clinical pharmacist interventions. In 97% of incidents, medical staff accepted the proposed interventions. The high rate of physician acceptance emphasizes the integral patient safety role of clinical pharmacy services. Further research is required to examine the influence of patient and clinical pharmacist characteristics on pharmacist interventions and physician acceptance.

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Authors' contributions

ROA's conceptualization, design, analysis, interpretation, and report and writing the manuscript were the major contributions to the writing of the research paper. YA and RG reviewed the design, interpretation, and report writing, and RMA and HA reviewed the design and manuscript writing. All authors read and approved the final manuscript.

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ORCID iD

Rana Omar AlKhanbashi https://orcid.org/0000-0002-5363-6526

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