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ORIGINAL RESEARCH

Effectiveness of Clinical Pharmacists-Led Medication Reconciliation to Prevent Medication Discrepancies in Hospitalized Patients: A Non-Randomized Controlled Trial

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Aim: Medication discrepancies are a major safety concern for hospitalized patients and healthcare professionals. Medication Reconciliation (MR) is a widely used tool in different practice settings to ensure the proper use of medications.

Objective: This study aimed to assess the effectiveness of the clinical pharmacists-led MR process in identifying, preventing, and resolving medication discrepancies among hospitalized patients.

Patients and Methods: This was a prospective study with an observational and interventional part, conducted at the Internal Medicine Department of a tertiary Hospital in Sudan from January to September 2023. The enrolled patients were divided into two groups, the observation group, in which the routine MR process was performed by doctors (usual care), and the intervention group, in which clinical pharmacists led the MR process.

Results: Compared to the usual care, the clinical pharmacists were more efficient in identifying and preventing medication discrepancies (P=0.001). From a total of 1012 medications, clinical pharmacists' interventions contributed to the detection of (39%) equivalent to 2.2 discrepancies per patient, resolving 325 (83%) and preventing (55%) clinically significant discrepancies. Dose discrepancy (43%) was the most common type of identified discrepancies. These interventions were accepted by (98%) of doctors and implemented in (86%) of the total cases. The main predictors of medication discrepancies ($P \leq 0.05$) for patients were the length of hospital stay, patient-hospital transfer, high number of medication histories, and increased number of medications used during hospitalization.

Conclusion: Through the implementation of the MR process, the clinical pharmacist's interventions substantially contributed to the detection and resolution of medication discrepancies among hospitalized patients. It is recommended that this intervention be disseminated in more hospitals in Sudan to encourage the implementation of appropriate practices.

Keywords: clinical pharmacists, medication reconciliation, medication discrepancies, Sudan

Introduction

Clinicians globally face challenges in capturing the most accurate medication list and utilizing it to determine treatment plans.[1] The Medication Reconciliation (MR) process is a standard practical tool in which healthcare professionals collaborate with patients to ensure accurate and comprehensive reporting of medications.[2] These reports were related to medication discrepancies and healthcare costs.[3] Medication discrepancies refer to the unexplained inconsistencies in reported medications between different healthcare providers or points of care.[4] Implementing a comprehensive medication history and MR program at hospital admission can significantly enhance patient safety and minimize medication-related issues throughout hospitalization and discharge.[5,6]

A study in Kuwait revealed that; despite the value of MR process implementation, doctors and pharmacists had low awareness of hospital policies.[7] However, the more effort and time devoted by pharmacists to obtain a comprehensive

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medication history than doctors reduce the prevalence of medication discrepancies obtained during transition points of care.[8]

Increased medication histories, polypharmacy, long hospital stays, medication non-adherence, and patient transfers between different care points are predictors that have been reported to increase the number of medication discrepancies for hospitalized patients.[9–14] Types of medication discrepancies can involve but are not limited to the following; an addition or omission of medication; alteration in dose, frequency, or route of administration; and an alternative agent within the same therapeutic class.[15]

Additionally, successful implementation of the MR process requires shared responsibility among healthcare professionals from all disciplines and support of safe systems.[16]

Sudan, as a developing nation, faces many challenges in clinical practice as a shortage of essential medications, a lack of doctors' training and guidance in communication, and patients from different cultural diversity markedly affecting the different health outcomes.[17] Clinical pharmacy services are an emerging specialty, and clinical pharmacists as drug experts are in a good position to lead the MR process.[4] This was the prime attempt in Sudan to assess the effectiveness of clinical pharmacists-led MR process in identifying, preventing, and resolving medication discrepancies among hospitalized patients.

Methodology

Participants and Setting

This was a prospective study with an observational and an interventional period,[5,18] conducted at the Internal Medicine Department of a tertiary hospital in Sudan from January to September 2023. The Wad Medani Teaching Hospital, founded in 1927, is a tertiary hospital in Gezira State, Sudan, with a capacity of 352 beds. Patients were eligible for the study if they were aged 18 years and above, had a length of hospital stay > 48 hours, and were willing to participate. The equality of baseline characteristics among participants for both periods was considered. The recruitment was carried out by consecutive admissions during the study period.

Study Design and Procedure

The study was divided into two periods (observational and interventional) of 4.5 months to avoid contamination bias. The enrolled patients were divided into two groups, the observational group, in which the routine MR process was performed by doctors, and the interventional group, in which the MR process was performed by clinical pharmacists.[5,18]

Sample Size Determination

The sample size for the patient participants was determined using the following equation.[19]

$$\text{Sample size} = \frac{\frac{Z^2 \times P(1-P)}{e^2}}{1 + \frac{Z^2 \times P(P-1)}{Ne^2}}$$

Z =confidence interval. P=population proportion. e=margin of error. N= population size.

We were considering that the collective patient population size from the Internal Medicine Department was 4768 (N) patients at the time of the study. Using a confidence interval of 95%, with a margin of error of 5% and a proportion of 50%, a sample size of 350 Patients was found to be appropriate for the study. Two-sided statistical tests were carried out, assuming a normal distribution. Sample size N was calculated for 350 patients, 170 for the observation group, and 180 for the intervention group.

Data Collection

Data were collected using a specifically modified MR form,[20] which was composed of two parts: the first part included patients' demographics, hospital transfer, diagnosis, and the length of hospital stay. The second part was the MR form, which was composed of a detailed history of pre-admission medications, the number and regimen of currently ordered medications, the number and types of identified discrepancies, and the final accurate list of medications after the MR

process was performed. For the observation group, two pharmacists performed the work by retroactively recording the conventional MR process of doctors obtaining patient medication history, reviewing, and reconciling medications. Two registered clinical pharmacy specialists with at least two years of work experience in the Internal Medicine ward joined the research team to perform proactively the MR process. Before starting, they attended three round-table discussions organized by the research investigator to explain the tools used, their roles, and their responsibilities throughout the study.[18]

Clinical Pharmacists' Interventions

The clinical pharmacist stayed with each patient for approximately 20 minutes and obtained a comprehensive medication history using different sources of information (medication vials and packages, previously discharged cards, old patient files, and patient or co-patient interviews). Then ensured that all ordered and used medications were documented in the medication records. Furthermore, the clinical pharmacist reconciled all the medications and formulated the final accurate and complete medication list.

Medication discrepancies were identified, corrected, and resolved, including incorrect drugs, dose discrepancy (strength, frequency, duration, and route of administration), addition of medications to the list, omission of medications from the list, and therapeutic duplication.[21] Further classifications were done for the medication discrepancies in the intervention group. The investigators classified medication discrepancies according to their clinical significance into four classes; a. extreme clinical importance (Medication discrepancies that require interventions to prevent severe, long-lasting, or irreversible harmful effects on health), b. major clinical importance (Discrepancies that require interventions to prevent major or reversible harmful effects, or when evidence-based treatment options are not provided for a condition), c. moderate clinical importance (Discrepancies where interventions may result in moderate benefit for the patient), and d. minor clinical importance (Discrepancies with little clinical relevance for the patient, such as minor adjustments to dosage regimens).[21]

Statistical Analysis

The data were processed using Statistical Package for the Social Sciences software version 25 (SPSS Inc., Chicago, IL, USA). Percentages, frequencies, and means were used for categorical and continuous variables. Comparisons of baseline characteristics between both groups were performed with a statistical *t*-test as appropriate to assess the equality of variances if the population of the two groups was comparable. Univariate analysis and logistic regression with a significance of 0.05 were used to find the predictors of different associations. The nonparametric independent samples Mann–Whitney U statistical test was used to determine the significant difference between both groups through the identified number of medication discrepancies.

Ethics Statement

This study adhered to the ethical guidelines of the 1975 Declaration of Helsinki and was approved by the Ethical Committee, Ministry of Health, and the University of Gezira, (Serial NO 40–19). All eligible patients were selected and asked to participate in the study after obtaining written informed consent. All collected checklists were coded to ensure confidentiality throughout the study.

Results

Patient Demographics and Clinical Characteristics

A total of 350 hospitalized patients from the Department of Internal Medicine were enrolled, with 170 and 180 patients in the observation and intervention groups, respectively. Patient inclusions were balanced between the observation group (49%), and the intervention group (51%). Patient demographics and characteristics for both groups, including age, gender, residency, level of education, and number of comorbid diseases on hospital admission, are shown in (Table 1). The mean age of patients was 50.63 ± 1.58 SD years and 49.34 ± 1.41 SD years for the observation group and intervention one respectively P= (0.195). Males in the observation group were 81 (48%), and in the intervention one were

Table 1 Patients' Demographics and Characteristics, Observation Group n=170, Intervention Group n=180

Age		**Mean ± SD**		**P value**
Observation group		50.63 ± 20.671		0.195
Intervention group		49. 34 ± 19.001		
Gender		**Frequency n%**	**Mean ± SD**	
Observation group	Males	81 (48%)	0.523 ± 0.500	0.085
	Females	89 (52%)		
Intervention group	Males	97 (54%)	0.461 ±0.491	
	Females	83 (46%)		
Residency		**Frequency n%**	**Mean ± SD**	
Observation group	Urban areas	39 (23%)	0.770 ± 0.421	0.104
	Rural areas	131 (77%)		
Intervention group	Urban areas	60 (33%)	0.706 ± 0.471	
	Rural areas	120 (67%)		
Level of Education		**Frequency**	**Mean ± SD**	
Observation group	Uneducated Primary Secondary University Postgraduate	122 (72%) 19 (11%) 17 (10%) 10 (6%) 21%)	0.511 ± 0.937	0.001
Intervention group	Uneducated Primary Secondary University Postgraduate	97 (54%) 44 (24%) 22 (12%) 14 (8%) 2(1%)	0.766 ± 1.014	
Number of Comorbid diseases		**Frequency**	**Mean ± SD**	
Observation group	Number of comorbid diseases on admission	190	0.950 ±0.801	0.062
Intervention group	Number of comorbid diseases on admission	212	1.001 ±0.912	

97 (54%), P= (0.085). There was no statistically significant difference between patients from both groups, for age and sex (Table 1).

The length of hospital stay for each patient was measured from admission to discharge, and the patient was either admitted directly to the general ward or transferred during different points of care. Also, there was no statistically significant difference in length of stay P= (0.071), and the main diagnosis P = (0.124) between patients from both groups (Table 2).

Medication Reconciliation Characteristics

Regarding medication history, the history in the observation group was obtained by doctors, and the total number of obtained medications was 199, compared to 354 medications obtained by clinical pharmacists in the intervention group (Table 3). The number of currently ordered and documented medications for the observation and intervention groups were 788 and 1031 respectively, as shown in (Table 3). Regarding the identified number of medication discrepancies, in the observation group from a total of 893 used medications after the MR process performed by doctors, 108 (12%), (0.6 discrepancy per patient) medication discrepancies were detected. In the intervention group, in which the MR process was

Table 2 Patient Length of Hospital Stay and Hospital Transfer Observation Group n=170 Intervention Group n=180

Length of hospital stay		Minimum	Maximum	Mean± SD	P value
Observation group	Number of stay-in days	2	31	7.27 ±3.230	0.071
Intervention group	Number of stay-in days	2	30	7.667 ±3.654	
Hospital admission and transfer		**Frequency n%**		**Mean± SD**	
Observation group	Direct admission to the ward Transferred in hospital	118 (69%) 52 (31%)		1.305 ±0.461	0.059
Intervention group	Direct admission to the ward Transferred in hospital	107 (59%) 73 (41%)		1.405±0.472	
Main diagnosis		**Frequency n%**		**Mean± SD**	
Observation group	Gastrointestinal system Cardiovascular system Central nervous system Infectious diseases	42 (25%) 25 (14%) 30 (18%) 73 (43%)		3.182± 2.998	0.124
Intervention group	Gastrointestinal system Cardiovascular system Central nervous system Infectious diseases	42 (23%) 32 (18%) 29 (16%) 77 (43%)		3.188 ±3.001	

Table 3 Medication Reconciliation Characteristics

Parameters	Observation group	Intervention group	P value
Total number of obtained medication history	199	354	0.103
Total number of current ordered and documented medications	788	1031	0.060
Total number of identified medication discrepancies	108 (12%)	391 (39%)	0.091
Total number of Resolved Medication discrepancies	53 (49%)	325 (83%)	0.133
Total number of the final accurate medication list	893	1012	0.082

performed by clinical pharmacists, from a total of 1012 used medications 391 (39%) (2.1 discrepancies per patient) medication discrepancies were identified and detected, as shown in (Table 3). Clinical pharmacists from a total of 391 medication discrepancies identified in the intervention group proposed that clinical interventions be discussed with doctors. The clinical pharmacist's recommendations resulted in the correction and resolution of 325 (83%) of the identified discrepancies (Table 3). The completeness of medication records was 73% in the observation group compared to 96% in the records completed by clinical pharmacists in the intervention group.

Of the cases that required a clinical pharmacist intervention, 88% of the total cases of the intervention group. The Clinical pharmacists' recommendations were accepted by 98% of doctors and fully implemented.

The Dose discrepancy was reported as the most frequent discrepancy at 40% and 41%, followed by medications omitted from the list at 25% and 30% in the observation group and intervention group respectively (Table 4).

The medication discrepancies identified by the clinical pharmacists were further classified into four classes by the investigators according to their clinical significance. The Extreme and major clinically important medication discrepancies represented 55% of the total discrepancies (Table 5). The significant predictors ($P \leq 0.05$) associated with the increased number of medication discrepancies identified by clinical pharmacists in the intervention group are shown in (Table 6). The predominant predictors in the univariate analysis were submitted to the logistic regression. The final model selects four

Table 4 Classification of Identified Medication Discrepancies According to Types

Groups	Incorrect drug	Dose discrepancy	Addition	Omission	Therapeutic Duplication
Observation group	12 (11%)	43 (40%)	14 (13%)	27 (25%)	12 (11%)
Intervention group	47 (12%)	159 (41%)	41 (10%)	119 (30%)	25 (7%)

Table 5 Classification of Medication Discrepancies in the Intervention Group According to Their Clinical Significance n=391

Types of Discrepancy	Sum of discrepancies	Percent n%
Minor clinical importance	59	15%
Moderate clinical importance	114	29%
Major clinical importance	108	27%
Extreme clinical importance	110	28%

Table 6 Predictors of Medication Discrepancies in a Univariate Model

Predictors	Mean Square	f	P value
Length of hospital stay in days	16.077	10.726	0.001
Hospital transfer	9.114	6.081	0.015
Number of currently used medication	27.104	18.083	0.001
Number of medication history	11.417	7.617	0.006
Number of comorbid diseases on admission	1.974	1.317	0.253
Age	0.628	0.419	0.518
Gender	0.225	0.150	0.699
Residency	0.340	0.227	0.635
Level of education	0.061	0.041	0.841
Diagnosis	0.149	0.100	0.753

main predictors or risk factors associated with an increased number of medication discrepancies. The length of hospital stay (OR= 1.333; 95% CI, 1.401–1.128; P = 0.000), patient's hospital transfer (OR= 1.218; CI 95%, 1.166–2.616; P = 0.017), increased number of currently used medications (OR= 1.251; CI 95%, 1.050–1.259; P= 0.002), and increased medication history on hospital admission (OR=1.211; CI 95%,1.027–1.317; P = 0.017) were the main predictors (Table 7).

Table 7 Identification of Risk Factors of Medication Discrepancies Estimated by Modeling a Logistic Regression

Predictors	Odds Ratio Confidence Interval 95%	P-value
Length of hospital stay in days	1.333 (1.401–1.128)	0.000
Hospital transfer	1.218 (1.166–2.616)	0.007
Number of currently used medication	1.251 (1.050–1.259)	0.002
Number of medication history	1.211 (1.027–1.317)	0.017

The independent sample Mann–Whitney *U*-test revealed that the distribution of the number of medication discrepancies obtained was not the same across the observation and intervention groups (P=0.001). This explains the significance of implementing the MR process in identifying and preventing discrepancies among hospitalized patients. Furthermore, to estimate the constant effect of the MR process performed by clinical pharmacists compared to the usual practice of doctors, the (OR= 4.558; 95% CI). This result revealed that; discrepancies may occur more often in 4.558 in the absence of clinical pharmacists' interventions.

Discussion

This study describes the first implementation of the MR process in clinical practice in Sudan and the first utilization of clinical pharmacy services to upgrade medication records and prevent discrepancies. The study evaluates the impact of clinical pharmacists' interventions through the implementation of the MR process in comparison to the conventional MR performed by doctors in their routine clinical practice. Then, different practice and clinical outcomes have been measured.

Concerning the demographic characteristics of enrolled patients, the gender, age distribution, and main diagnosis in both groups were approximately equal, this is consistent with a study conducted in Jordan of the Internal Medicine population.[5,22] On hospital admission, clinical pharmacists applied structured medication history taking using different sources of information and obtained 354 medications compared to 199 in the observation group. A project conducted at the Internal Medicine Services, University of Virginia, found that; pharmacists obtained medication histories more thoroughly, and used different sources of patient information than physicians.[23,24] Our study shows that most clinical pharmacists' interventions' are concerned with dosing, incomplete medication records (addition and omission of medication from the list), and indications in terms of therapeutic duplications.[4] Extreme and major clinically important medication discrepancies represented 55% of the total discrepancies, in contrast to a study conducted in general Internal Medicine units, at the University of Toronto in which only 38.6% of medication discrepancies were judged to cause severe clinical deterioration.[19] The clinical pharmacists' interventions resulted in the prevention of 2.1 discrepancies per patient during the hospital stay.[17] From another perspective, the high acceptance rate of doctors to the clinical pharmacists' recommendations is an important parameter in evaluating the role of a clinical pharmacist in leading the MR process in a hospital.

The model used to represent the significant predictors of the increased number of medication discrepancies explained that an increased number of medication history has positive associations with medication discrepancies, this result was similar to a study conducted in the Netherlands that reported the same finding.[25] Increased length of hospital stay and hospital transfer were also found to have a positive association with an increased number of medication discrepancies.[10] The increased number and complex regimen of medications during hospitalization increase medication discrepancies.[26] The association between long-term hospitalization, the high number of used medications, and discrepancies suggest that more intensive reconciliation and education efforts could be targeted toward patients taking these medications. Documentation of daily pharmacists' care activities serves as a template to show the quality of service for standards of medical practice and eventually enhance communication among the healthcare team.[18] Our interesting finding in this study was the identified number of medication discrepancies after the implementation of the MR process by clinical pharmacists, this result came consistent with a study conducted in two general medicine wards in a French hospital, which revealed that; medication discrepancies occur more often when there is no clinical pharmacists' interventions.[5] Several studies proved that; clinical pharmacists were more efficient in identifying medication discrepancies than doctors and should possess the key role in the implementation of the MR process in different practice settings.[27,28]

This work had a great impact on the clinical practice in Sudanese hospitals. In the last few years, Sudan has suffered from different economic and political complications, and this had a remarkable negative impact on the various healthcare outcomes. Therefore, raising awareness and training the medical staff to incorporate the MR at all transition care points from admission to discharge will improve clinical practice and healthcare outcomes.

Strengths and Limitations

Despite the extensive efforts in this study to achieve proper implementation of the MR process by clinical pharmacists, its implementation has been challenging. A limitation of this study is that it was not a randomized control trial, it is a pragmatic study and conducted in a single department. Second, patients with different cultural diversities may impair the communication process to some extent. Third, the unavailability and shortage of medications in Sudan have increased the rate of discrepancies. On the other hand, the strengths and encouraging points of our study are the support of policymakers in the hospital, good coordination and communication with doctors, and dissemination of the process through clinical meetings for future implementation plans in other hospital departments.

Conclusion

Through the implementation of the MR process, the clinical pharmacists' interventions substantially contributed to the detection, resolution, and prevention of medication discrepancies in hospitalized patients. The clinical pharmacists' recommendations were accepted by doctors and fully implemented. It is recommended that this intervention be disseminated in more hospitals in Sudan to encourage the implementation of appropriate practices.

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Disclosure

Authors declare that; they have no conflict of interest for this work.

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