



Evaluation of Pharmaceutical Care Services and Their Impact on Medication Safety in Hospitalized Patients

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Abstract

The changes in documented drug-related problems following pharmacist-led pharmaceutical-care intervention among hospitalized patients and to describe the pharmacist interventions used to address identified medication-related problems. Drug-related problems can compromise the safety and appropriateness of pharmacotherapy in hospitalized patients. Pharmacist-led pharmaceutical care provides a structured approach to medication review, identification of medication-related problems, and communication of therapeutic recommendations. A data analysis was conducted using previously generated aggregate data from a pharmacist-led intervention study. Documented drug-related problems were examined at baseline and endpoint across the reported medication-related categories. Absolute changes and percentage reductions were calculated from the available baseline and endpoint counts. Documented pharmacist intervention categories were also reviewed. The overall number of documented drug-related problems decreased from 230 at baseline to 123 at endpoint, corresponding to a 46.52% reduction. Reductions were observed across most categories, including inappropriate drug selection according to guidelines or formulary recommendations, inappropriate drug combinations, excessive medication use, and dose-related problems. Smaller reductions were observed for inappropriate duplication and medication use without an indication. The findings demonstrate variation in the magnitude of change between individual drug-related problem categories. The findings indicate that pharmacist-led pharmaceutical care was accompanied by a reduction in documented drug-related problems among hospitalized patients. Structured medication review and pharmacist intervention may support safer and more appropriate medication use. Further prospective studies using patient-level data are warranted to evaluate clinical outcomes and establish the longer-term contribution of pharmacist-led pharmaceutical care.

Keywords: Drug-related problems, Hospitalized patients, Medication safety, Pharmaceutical care, Pharmacist intervention

1. Introduction

Medication safety is an important component of high-quality healthcare since medication use involves multiple stages, including prescribing, dispensing, administration, monitoring, and follow-up. Errors or weaknesses at any stage may result in preventable harm to patients. Although substantial progress has been made in patient-safety practices, medication errors remain a continuing concern across healthcare settings. AlKhanbashi *et al.* (2024) highlighted that patient safety requires sustained attention to system-level factors, while Tawhari *et al.* (2022) emphasized the importance of systematic strategies for preventing medication errors within hospitals. These concerns are particularly relevant to hospitalized patients, who may experience complex treatment regimens, multiple transitions in care, and frequent medication changes during their admission.

Pharmaceutical care provides a structured approach through which pharmacists contribute to the optimization of medication therapy and the prevention or resolution of medication-related problems. Medication review is an

important component of this process and involves a systematic assessment of a patient's medicines to ensure that therapy is appropriate, effective, safe, and consistent with the patient's needs. Griese-Mammen *et al.* (2018) demonstrated the importance of establishing a clear and consistent definition of medication review, reflecting its role as a structured professional activity rather than simply a review of a medication list. In hospital practice, systematic medication review can help pharmacists identify inappropriate therapy and potential medication-related risks before these problems result in adverse outcomes (Mazhar *et al.*, 2017).

Medication errors can occur at different points within the medication-use process and may involve prescribing, dispensing, administration, or monitoring. Lavan *et al.* (2016) described the challenges of reducing prescribing errors, particularly among patients with multimorbidity and complex medication requirements. Similarly, Nanji *et al.* (2016) demonstrated that medication errors and adverse drug events can occur in perioperative care, highlighting the vulnerability of hospitalized patients during periods of intensive clinical management. Interdisciplinary collaboration is another important element of medication safety. According to Manias (2018), collaboration among healthcare professionals can influence medication-error prevention by improving communication, coordination, and shared responsibility for medication management.

Clinical pharmacists have an important role in identifying medication-related problems and recommending appropriate interventions. Their involvement may include medication reconciliation, medication review, patient education, communication with prescribers, and follow-up of medication-related concerns. Hohl *et al.* (2017) examined early in-hospital medication review by clinical pharmacists and demonstrated the relevance of pharmacist participation in hospital medication management. Similarly, Phatak *et al.* (2016) evaluated pharmacist involvement in transitional care through medication reconciliation, medication education, and post-discharge follow-up. These activities illustrate how pharmacist services can extend across different stages of patient care and address medication-related risks that might otherwise remain unidentified.

Medication reconciliation is particularly important when patients move between different stages of healthcare. Changes in medication lists, incomplete information, and discrepancies between prescribed and previously used medicines may contribute to medication errors. Pharmacist participation in medication reconciliation can help identify discrepancies and clarify medication regimens. Phatak *et al.* (2016) specifically examined pharmacist involvement in transitional care, while Hohl *et al.* (2017) investigated the effects of early medication review during hospitalization. Together, these studies demonstrate the relevance of structured pharmacist involvement in improving the management of medication therapy in hospital settings.

Pharmaceutical interventions may also contribute to medication safety by addressing identified medication-related problems directly. Farhat *et al.* (2021) evaluated pharmaceutical interventions among hospitalized patients and compared clinical pharmacist interventions with an explicit criteria-based approach. Their work illustrates the potential value of pharmacist assessment in identifying medication-related concerns that require clinical attention. Collaborative approaches may provide an additional mechanism for strengthening medication safety. Leguelinel-Blache *et al.* (2018) developed the MEDREV study to investigate the impact of collaborative pharmaceutical care on medication safety among inpatients, reflecting growing interest in multidisciplinary approaches to medication review and optimization.

Technological developments have further expanded the possibilities for medication-safety improvement. Health information technology can support the collection, communication, and management of medication information and may contribute to safer healthcare processes (Alotaibi and Federico, 2017). Bar-code medication administration is one example of a technology-based intervention intended to reduce administration errors. Owens *et al.* (2020) examined the implementation of bar-code medication administration in an emergency department and its relationship with medication administration errors and nursing satisfaction. At the same time, telepharmacy has created opportunities for pharmacists to provide services across geographical and organizational boundaries. Reviews by Poudel and Nissen (2016) and Alghamdi (2026) describe the clinical potential and challenges associated with telepharmacy services.

The pharmacist's contribution is not limited to medication-error prevention. Pharmaceutical interventions may also influence healthcare resource utilization and costs. Al Hamid *et al.* (2016) discussed the role of pharmacists in reducing healthcare costs, while pharmacist-led medication review may help identify unnecessary, inappropriate, or potentially harmful medication use. Education and appropriate medication review are also important components of pharmaceutical care. Poots *et al.* (2020) examined perspectives concerning medication review and deprescribing education, highlighting the need for healthcare professionals to develop appropriate skills for optimizing medication therapy. These aspects are particularly relevant where patients receive multiple medicines and require regular reassessment of treatment.

The safety of medicines can also be affected by factors beyond conventional prescribing and administration processes. Medication shortages, for example, may require changes in treatment or substitution of available medicines. Phuong *et al.* (2019) reported that medication shortages can have consequences for patient care and clinical outcomes. In addition, the increasing use of artificial intelligence and digital technologies is creating new opportunities for pharmacy practice. Al-Jedai *et al.* (2016) reviewed applications of artificial intelligence in pharmacy practice, demonstrating the expanding role of technology in medication-related decision-making and pharmaceutical services. Nevertheless, these developments complement rather than replace the clinical assessment and professional judgment provided by pharmacists (Babelghaith *et al.*, 2020).

Despite advances in medication-safety practices, hospitalized patients remain exposed to medication-related risks due to complex therapies, multiple healthcare professionals, frequent treatment changes, and transitions in care.

Evidence supporting medication review, reconciliation, pharmacist intervention, and collaborative pharmaceutical care indicates that pharmacists can contribute to identifying and addressing such problems. Therefore, examining documented drug-related problems and the interventions used to address them can provide useful information about the practical contribution of pharmaceutical care to medication safety in hospital practice.

The study focuses on documented drug-related problems and pharmacist-led pharmaceutical-care interventions among hospitalized patients. By examining the distribution of medication-related problems before and after pharmacist intervention and describing the corresponding intervention patterns, the study seeks to provide a structured assessment of changes in medication-related problems and the role of pharmaceutical care in hospital medication management.

The study had two objectives: to describe the distribution and frequency of documented drug-related problems across different medication-related categories before and after pharmacist-led pharmaceutical-care intervention among hospitalized patients; and to assess the changes in documented drug-related problems following the intervention and describe the types of pharmacist interventions used to address these medication-related problems.

2. Materials and Methods

2.1 Study Design

The study was a secondary analysis of previously generated aggregate data from a prospective, open-label randomized controlled trial investigating clinical pharmacist-led interventions for drug-related problems (DRPs) among patients with chronic kidney disease. A total of 100 patients were enrolled and randomized equally into control and intervention groups, with 50 patients in each group. The analysis focused on the documented DRPs and pharmacist-led interventions reported for the intervention group at baseline and endpoint.

2.2 Study Population

The source study included patients with chronic kidney disease who fulfilled the predefined eligibility criteria and received care in the nephrology unit. Eligible participants were randomized in a 1:1 ratio to either the usual-care control group or the clinical pharmacist-led intervention group. The intervention group comprised 50 patients. Patients who did not meet the eligibility requirements were excluded according to the criteria established in the original trial. For the data, no new participants were recruited, and no additional patient intervention was performed. The analysis was restricted to the previously documented intervention-group information concerning DRPs and pharmacist interventions.

2.3 Classification of Drug-Related Problems

DRPs in the intervention group were identified at baseline by a clinical pharmacist using the Pharmaceutical Care Network Europe classification system. Kidney-related clinical practice guidelines and the British National Formulary were used as reference sources for assessing medication appropriateness and renal dose adjustment. Lexicomp was additionally used to identify potential drug-drug interactions and assess their severity. The documented DRP categories included inappropriate drug selection, inappropriate drug combinations, duplication, lack of indication, excessive medication use, and dosing-related problems. The analysis retained the categories reported in the original study without reconstructing individual patient records.

2.4 Pharmacist-Led Intervention

Patients assigned to the intervention group received a pharmacist-led counseling session lasting approximately 15–20 minutes. The counseling addressed disease-related knowledge, medication reconciliation, the need for appropriate dose adjustment, and potential consequences of drug-drug interactions. Following identification of DRPs, recommended interventions were communicated to the physician or nephrologist and documented according to the PCNE 9.1 framework. Reported interventions included proposals to prescribers, discussions with prescribers, dosage changes, changes in medication instructions, temporary or permanent discontinuation of medicines, and initiation of medicines. The analysis used these documented intervention categories to describe the pharmaceutical-care activities provided during the original study.

2.5 Outcome Measures

The data were the change in documented DRPs between baseline and endpoint among patients in the pharmacist-led intervention group. DRPs were examined both as an overall count and according to individual problem categories. The analysis also described the documented pharmacist intervention categories and their reported implementation status. Absolute change was calculated as the baseline number of DRPs minus the endpoint number.

2.6 Ethical Considerations

The underlying randomized controlled trial received ethical approval from the Institutional Review Board, and participants in the original study provided informed consent. The study used previously generated aggregate study data and did not involve recruitment of new participants or additional patient interventions. The original study and associated deposited datasets were appropriately cited.

3.Results

3.1 Pattern of Drug-Related Problems Across the Intervention Period

The distribution of drug-related problems (DRPs) demonstrated a reduction across all reported categories between baseline and endpoint. DRPs decreased from 230 at baseline to 123 at endpoint, corresponding to a 46.52% reduction as shown in Table 1. Inappropriate drug combinations and other causes showed the largest category-specific reductions, each reaching 60.00%. Problems involving drugs considered inappropriate according to guidelines or formularies declined from 73 to 35, representing a 52.05% reduction. Excessive dosing decreased from 19 to 8 cases, while insufficient dosing declined from 7 to 3. Inappropriate duplication showed the smallest reduction, decreasing from 14 to 13 cases.

Table 1. Distribution of Drug-Related Problems Before and After Pharmacist-Led Intervention

Drug-related category	problem	Baseline (n)	Endpoint (n)	Reduction (%)
Overall problems	drug-related	230	123	46.52
Inappropriate according to guidelines/formulary	drug to	73	35	52.05
No indication for drug		4	3	25.00
Inappropriate drug combinations	drug	50	20	60.00
Inappropriate duplication		14	13	7.14
Too many drugs for indication		48	35	27.08
Too low a dose		7	3	57.14
Too high a dose		19	8	57.89
Other causes		15	6	60.00

Source: Data from the dataset deposited by Zafar et al. (2025).

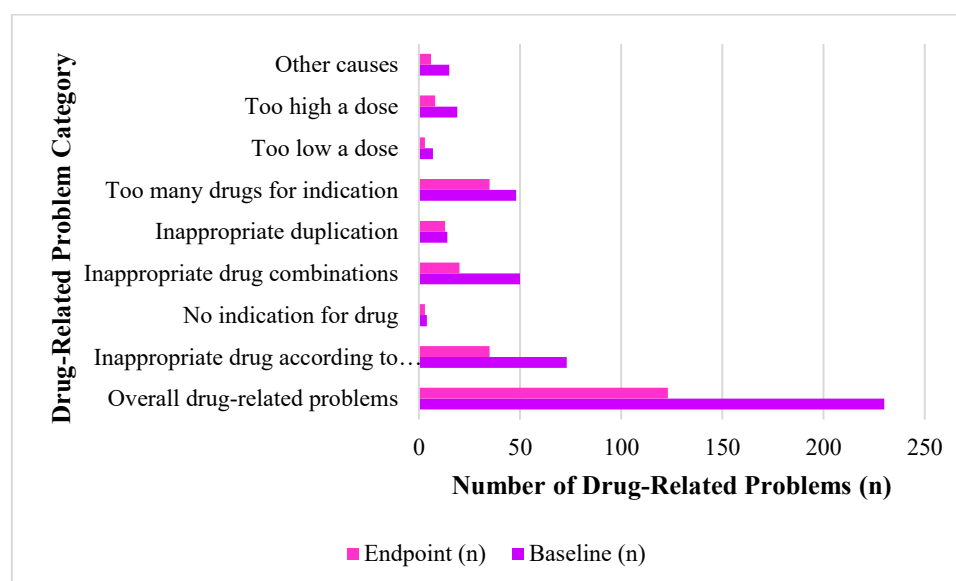


Figure 1. Distribution of Drug-Related Problems Before and After Pharmacist-Led Intervention

The overall distribution of drug-related problems recorded before and after the pharmacist-led intervention. A noticeable reduction was observed in the total number of reported problems at the endpoint compared with baseline, as shown in Figure 1. Decreases were also evident for inappropriate drug selection according to guidelines, inappropriate drug combinations, excessive medication use for an indication, and both low- and high-dose problems. The number of cases involving inappropriate duplication and absence of a drug indication also showed smaller reductions. The pattern indicates a decline across the assessed drug-related problem categories during the intervention period, although the extent of reduction varied between individual categories.

3.2 Changes Observed in Medication-Related Problems

The comparative assessment showed a substantial decline in the recorded number of DRPs following pharmacist-led pharmaceutical care. The overall number decreased by 107 cases, from 230 at baseline to 123 at endpoint. Inappropriate drug combinations declined by 30 cases, while guideline- or formulary-related problems decreased by 38 cases, as shown in Table 2. The number of cases involving too many drugs for an indication fell by 13,

whereas excessive-dose problems declined by 11. Smaller absolute reductions were observed for inappropriate duplication and absence of an indication. These findings demonstrate reductions across each DRP category reported in the deposited dataset.

Table 2. Changes in Drug-Related Problems Following Pharmacist-Led Pharmaceutical Care

Drug-related category	problem	Baseline (n)	Endpoint (n)	Absolute change (n)	Percentage reduction (%)
Overall	drug-related problems	230	123	107	46.52
Inappropriate drug according to guidelines/formulary		73	35	38	52.05
No indication for drug		4	3	1	25.00
Inappropriate drug combinations	drug	50	20	30	60.00
Inappropriate duplication		14	13	1	7.14
Too many drugs for indication		48	35	13	27.08
Too low a dose		7	3	4	57.14
Too high a dose		19	8	11	57.89
Other causes		15	6	9	60.00

Source: Data from the deposited dataset from Zafar et al. (2025); absolute changes and percentage reductions were calculated from the deposited baseline and endpoint values.

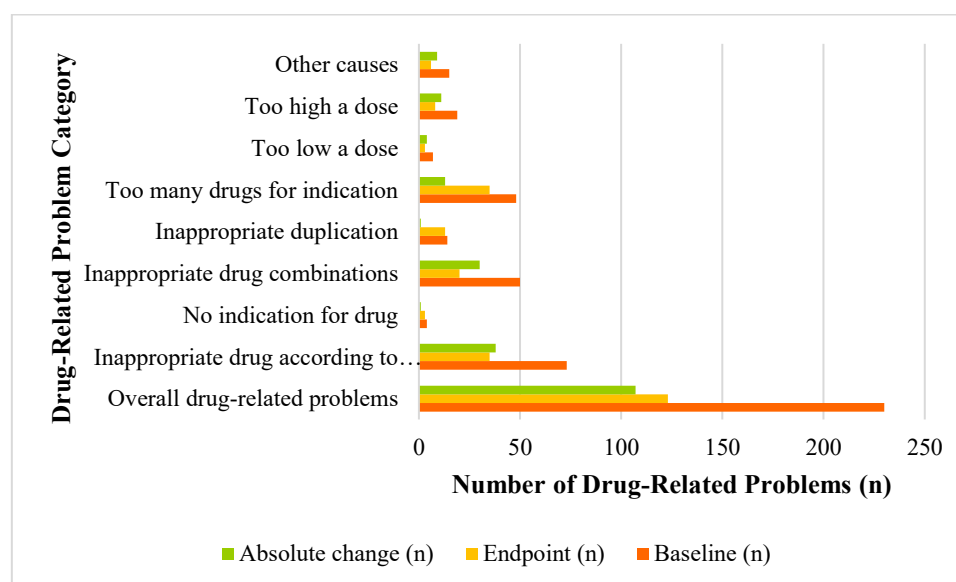


Figure 2. Changes in Drug-Related Problems Following the Intervention

A reduction in drug-related problems across the categories assessed during the intervention period. The overall number of reported problems decreased between baseline and endpoint measurements. Reductions were also observed in inappropriate drug selection according to guidelines or formulary recommendations, inappropriate drug combinations, excessive medication use for a given indication, and dose-related problems, as shown in Figure 2. A smaller change was observed for inappropriate duplication and drugs prescribed without an indication. The pattern shown in the figure indicates that drug-related problems declined across most categories following pharmacist-led pharmaceutical care, with the magnitude of change varying between individual problem categories.

4. Discussion

The study examined the pattern of documented drug-related problems before and after pharmacist-led pharmaceutical care intervention among hospitalized patients. The findings showed a reduction in the number of reported drug-related problems at the endpoint, with reductions observed across most of the assessed categories. The findings are relevant to hospital pharmacy practice since medication-related problems may arise from inappropriate drug selection, dosing, combinations, duplication, and other prescribing-related factors. Pharmaceutical care provides pharmacists with an opportunity to identify such problems systematically and communicate recommendations to prescribers. Sevilla-Sánchez and Tuset-Creus (2020) emphasized that pharmaceutical care in hospitalized patients involves active pharmacist participation in medication management and is directed toward optimizing pharmacotherapy and improving patient care.

The observed reduction in drug-related problems is consistent with the broader role of clinical pharmacy services in medication-safety management. Schepel *et al.* (2019) described the evolution of clinical pharmacy services in hospitals and highlighted the increasing involvement of pharmacists in medication review, medication reconciliation, and identification of medication-related risks. These activities are particularly relevant when patients receive multiple medicines or undergo frequent changes in therapy during hospitalization. In the analysis, the decline in drug-related problems across several categories suggests that systematic pharmacist involvement was associated with fewer documented medication-related concerns during the assessed intervention period. However, the analysis is based on documented aggregate intervention-group data; the findings should be interpreted as observed changes rather than as independent proof of causality.

A notable finding was the reduction in problems related to inappropriate medication selection according to guidelines or formulary recommendations. Appropriate drug selection is a fundamental component of safe pharmacotherapy since medicines should be selected according to the patient's clinical condition, treatment objectives, contraindications, and available clinical guidance. Pharmacist medication review can provide an additional level of scrutiny before inappropriate treatment continues. Ribed *et al.* (2016) demonstrated the potential contribution of pharmaceutical-care programs to medication safety in an outpatient onco-hematology setting, reporting benefits related to pharmaceutical-care activity and patient satisfaction. Although their clinical population differed from the hospitalized population considered in the analysis, their findings support the broader importance of structured pharmaceutical-care programs in identifying and addressing medication-related concerns.

The reduction in inappropriate drug combinations is another important finding. Medication combinations may increase the risk of therapeutic duplication, interactions, adverse effects, or inappropriate treatment when they are not clinically justified. Pharmacists can review complete medication regimens and identify combinations that require modification, discontinuation, or closer monitoring. Clinical pharmacy services have progressively incorporated activities aimed at improving medication safety within hospital systems. In the study, the reduction observed in inappropriate combinations indicates that medication review and pharmacist recommendations may have contributed to the identification and management of these problems. Nevertheless, the available aggregate data do not allow assessment of the specific clinical rationale behind every individual intervention.

The findings concerning excessive medication use are also relevant since polypharmacy can complicate medication management. Wastesson *et al.* (2018) reviewed the clinical consequences of polypharmacy in older adults and described associations between multiple medication use and several adverse clinical consequences. Although the analysis was not restricted to older adults, the issue of unnecessary or excessive medication use remains relevant to hospitalized patients receiving complex treatment. The observed decline in problems involving too many drugs for an indication may indicate that pharmacist review helped identify opportunities for medication optimization. Such review can support rational prescribing by encouraging consideration of whether each medicine has an appropriate indication and whether its continued use remains justified.

Dose-related problems also declined during the intervention period. Both insufficient and excessive dosing can compromise pharmacotherapy: inadequate doses may result in ineffective treatment, whereas excessive doses may increase the risk of adverse effects. Pharmacists are well positioned to review dosing regimens against clinical guidance and patient-specific factors. Pharmaceutical care plays an important role in ensuring appropriate medication use among hospitalized patients. The reduction in both low-dose and high-dose problems in the analysis therefore represents an important component of the overall pattern of medication optimization. However, the aggregate data do not provide sufficient information to determine whether individual dose modifications resulted in subsequent clinical outcomes.

A smaller reduction was observed for inappropriate duplication and drugs prescribed without an indication. These findings demonstrate that the magnitude of change was not uniform across all DRP categories. Differences between categories may reflect variations in the underlying causes of medication problems, prescribing practices, clinical requirements, or opportunities for intervention. Therefore, the overall reduction should not be interpreted as evidence that every type of drug-related problem was equally responsive to pharmaceutical care. Instead, the results indicate that pharmacist intervention was accompanied by varying degrees of change across individual medication-related categories.

The documented pharmacist interventions provide further context for these findings. Pharmaceutical care commonly involves communication with prescribers, modification of medication regimens, changes to instructions, discontinuation or initiation of medicines, and other actions directed toward resolving identified problems. Pharmaceutical care programs can incorporate medication-related interventions while also considering patient perspectives and satisfaction. In hospital practice, effective communication between pharmacists and other healthcare professionals is therefore an important component of medication optimization. The intervention pattern observed in the study reflects this collaborative nature of pharmaceutical care.

The findings are also relevant to medication safety during periods when healthcare systems face additional challenges. Zheng *et al.* (2021) discussed recommendations for pharmaceutical-care services during the COVID-19 pandemic and emphasized the need for pharmacists to adapt medication-related services to changing healthcare circumstances. Although the analysis does not specifically evaluate pandemic-related pharmaceutical care, the broader principle remains applicable: pharmacists can support continuity, review, and optimization of medication therapy when treatment becomes complex, or healthcare processes are disrupted. This reinforces the importance of integrating pharmaceutical-care activities into routine hospital medication-management systems.

Several limitations should be considered when interpreting the findings. First, the work is a data of previously generated study data rather than a newly conducted prospective investigation. Second, the available results are aggregated, which limits patient-level analysis and prevents examination of relationships between individual patient characteristics and specific drug-related problems. Third, the analysis primarily describes changes in documented DRP counts and therefore cannot establish whether individual interventions directly produced the observed changes. Fourth, the findings originate from the population and healthcare setting represented in the source study and may not be directly generalizable to all hospitals or patient populations. These limitations should be clearly acknowledged when interpreting the results.

Overall, the findings support the relevance of structured pharmacist involvement in identifying and addressing medication-related problems among hospitalized patients. The observed reductions across several DRP categories are consistent with the established role of clinical pharmacy services in medication review and medication safety. The results also emphasize the importance of reviewing medication appropriateness, combinations, duplication, indications, and dosing as interconnected components of pharmaceutical care. Future studies using prospective patient-level data and appropriate comparator groups could provide stronger evidence regarding the clinical effectiveness and long-term outcomes of pharmacist-led interventions.

5. Conclusion

The study indicates that pharmacist-led pharmaceutical care was accompanied by a reduction in documented drug-related problems among hospitalized patients. The decline was observed across several medication-related categories, including inappropriate drug selection, inappropriate drug combinations, excessive medication use, and dose-related problems. These findings highlight the value of systematic pharmacist involvement in reviewing medication therapy and identifying problems that may require therapeutic modification. Pharmacist interventions involving recommendations to prescribers, dosage changes, modification of medication instructions, and initiation or discontinuation of medicines provide practical mechanisms for addressing identified drug-related problems. The findings therefore support the integration of structured pharmaceutical-care activities into hospital medication-management practices to promote more appropriate and safer medicine use. However, the findings are based on previously generated aggregate study data and should consequently be interpreted as documented changes rather than definitive evidence of a causal treatment effect. Further prospective research using patient-level data, appropriate comparison groups, and clinically relevant follow-up outcomes would help determine the longer-term contribution of pharmacist-led pharmaceutical care to medication safety and patient outcomes.

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