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Impact of pharmacist-led medication reconciliation on preventable medication errors at hospital discharge: A prospective comparative study

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Abstract
Background: Transitions of care, particularly at hospital discharge, are critical points for medication safety, where unintentional discrepancies and prescribing errors commonly occur. Pharmacist-led medication reconciliation has emerged as a validated strategy to minimize preventable medication errors and optimize therapeutic outcomes.
Objective: This study aimed to evaluate the impact of pharmacist-led medication reconciliation on preventable medication errors at hospital discharge compared with standard discharge practices, using standardized assessment tools such as the WHO-UMC causality scale and the NCC MERP error classification system. Secondary objectives included analyzing drug-related problems (DRPs), potentially inappropriate medications (PIMs), 30-day readmissions, and cost-avoidance outcomes.
Methods: A prospective comparative study was conducted over six months in a tertiary care hospital involving 240 patients, randomized equally into a control group (standard discharge) and an intervention group (pharmacist-led reconciliation). Medication discrepancies were identified, categorized using NCC MERP, and causality assessed using WHO-UMC. PIMs were determined using Beers and STOPP/START criteria, and DRPs were classified according to PCNE guidelines. Statistical analysis employed chi-square and t-tests, with $p < 0.05$ considered significant.
Results: The pharmacist-led group demonstrated a 57.9% reduction in total discharge medication discrepancies (74 vs. 176; $p < 0.001$). The mean number of discrepancies per patient decreased from 1.47 to 0.62, while severe errors (NCC MERP categories C-E) were significantly fewer in the intervention group. DRPs were reduced from 139 to 61, and PIM prevalence among elderly patients (≥65 years) decreased from 40% to 20.7%. Thirty-day readmission rates showed a declining trend (17.5% vs. 9.2%), reaching statistical significance in high-risk subgroups ($p = 0.04$). The intervention also yielded favorable cost-avoidance outcomes consistent with published economic models.
Conclusion: Pharmacist-led medication reconciliation at discharge substantially reduces preventable medication errors, enhances medication safety, decreases DRPs and PIMs, and potentially lowers readmissions and healthcare costs. Incorporating pharmacists as integral members of discharge teams should be a standard practice in hospital care systems to ensure safe and effective transitions of therapy.

Keywords: Pharmacist-led medication reconciliation, hospital discharge, preventable medication errors, drug-related problems, NCC MERP, WHO-UMC, polypharmacy, potentially inappropriate medications, clinical pharmacy, readmission reduction, medication safety, hospital practice

Introduction

Medicinal plants have greatly gained importance in the management and treatment of human in contemporary hospital practice, transitions of care particularly at discharge represent critical points for medication safety, where the risk of preventable medication errors is high due to unintentional discrepancies, omissions, duplications, or inappropriate changes in therapy [1, 2]. Such errors contribute significantly to adverse drug events (ADEs), hospital readmissions, and increased healthcare costs [3, 4]. Studies have shown that pharmacist-led medication reconciliation, a structured review of medications across transitions of care, effectively minimizes discrepancies and improves patient safety outcomes [5, 6]. The World Health Organization (WHO) reports that nearly two-thirds of patient medication lists contain at least one error, and a quarter of prescribing errors arise from incomplete or inaccurate documentation [7]. Evidence demonstrates that systematic pharmacist involvement in discharge medication review leads to reductions in drug-related problems (DRPs),

preventable medication errors, and potentially inappropriate medications (PIMs), particularly among the elderly and multimorbid populations [8-10].

Medication reconciliation tools such as the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) index and the WHO-Uppsala Monitoring Centre (WHO-UMC) causality system provide standardized frameworks to assess error severity and causality, facilitating objective comparisons between interventions and routine care [17, 18]. Pharmacist-led reconciliation has been associated with improved communication among healthcare providers, enhanced documentation accuracy, and cost-avoidance through the prevention of high-risk prescribing errors [11-13]. Randomized and observational studies have confirmed that these interventions significantly reduce clinically important medication discrepancies, particularly in complex cases involving polypharmacy and high-risk medicines [14-16]. Despite this growing evidence, traditional discharge processes in many hospitals remain physician- or nurse-led, often overlooking the pharmacist's potential to identify and resolve clinically relevant discrepancies before discharge.

Therefore, this prospective comparative study aims to compare standard discharge procedures with pharmacist-led reconciliation using validated classification tools (WHO-UMC and NCC MERP) to quantify error reduction, assess DRP classifications, identify PIMs in high-risk subgroups, and estimate cost-avoidance benefits. The primary objective is to determine whether pharmacist involvement at discharge significantly decreases preventable medication errors compared with standard practice. Secondary objectives include evaluating DRP trends, PIM prevalence in elderly and multimorbid patients, 30-day readmission rates, and the economic implications of error prevention. The study hypothesizes that pharmacist-led reconciliation will yield a statistically significant reduction in preventable medication errors, DRPs, and readmissions, alongside measurable cost savings, compared to standard discharge care [1-18].

Materials and Methods

Materials

This prospective comparative study was conducted in the inpatient medical and surgical wards of a tertiary care teaching hospital over a 6-month period. Ethical approval was obtained from the institutional review board before initiation. Eligible participants included adult inpatients (≥18 years) prescribed at least one chronic medication and scheduled for discharge. Exclusion criteria comprised psychiatric inpatients, terminally ill patients, and those discharged against medical advice [1-3]. The study population was stratified into two groups: (a) the control group, receiving standard physician/nurse-led discharge procedures, and (b) the intervention group, where a clinical pharmacist performed structured medication reconciliation prior to discharge [4-6].

Pharmacists utilized patient case sheets, medication charts, discharge summaries, and interviews with patients or caregivers to identify medication discrepancies, which were classified using the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) index [17]. Each identified drug-related problem (DRP) was categorized according to the Pharmaceutical Care Network Europe (PCNE) classification and causality determined using the World Health Organization-Uppsala Monitoring Centre (WHO-UMC) criteria [18]. Potentially inappropriate medications (PIMs) among elderly patients (≥65 years) were assessed using Beers criteria and STOPP/START guidelines [15, 16]. Data on high-risk medicines (e.g., anticoagulants, insulin, opioids) were separately recorded due to their elevated error potential [7, 8]. The primary outcome measure was the proportion of preventable medication errors at discharge, while secondary outcomes included number of DRPs, PIM prevalence, 30-day readmissions, and estimated cost-avoidance [9-11].

Methods

A structured pharmacist-led medication reconciliation protocol was developed in line with WHO's "Medication Without Harm" framework [12, 13]. For each patient, the pharmacist compared pre-admission, inpatient, and discharge medications to identify unintended discrepancies. Detected discrepancies were discussed with the attending physician, and any accepted interventions were documented. The severity of each medication error was graded using the NCC MERP categories (A-I), and causality was evaluated using WHO-UMC criteria [17, 18].

All data were entered into a prevalidated Microsoft Excel sheet and analyzed using SPSS v25.0. Descriptive statistics (mean ± SD, frequency, percentage) were used to describe demographic and clinical variables. Chi-square and independent t-tests were applied to compare categorical and continuous variables between groups, respectively, with $p < 0.05$ considered statistically significant [10, 14]. Subgroup analyses were performed for elderly, polypharmacy (≥5 drugs), and multimorbid patients. Cost-avoidance was estimated based on average cost per prevented ADE, as reported in previous economic evaluations of pharmacist interventions [1, 5, 6]. The methodological framework aligns with previous high-quality studies on medication reconciliation, ensuring external validity and reproducibility [2, 4, 9, 11, 13, 15-18].

Results

A total of 240 patients were enrolled during the 6-month study period, with 120 allocated to the standard discharge (control) group and 120 to the pharmacist-led medication reconciliation (intervention) group. Both groups were comparable at baseline in terms of age, sex, number of comorbidities, and polypharmacy status ($p > 0.05$), indicating that subsequent differences in outcomes could be attributed primarily to the intervention rather than baseline imbalances [1-4, 9].

Table 1: Baseline demographic and clinical characteristics of study participants (n = 240)

Variable	Control (n = 120)	Intervention (n = 120)	p-value
Mean age, years (SD)	63.4 (11.8)	64.1 (10.9)	0.62
Male (%)	68 (56.7)	65 (54.2)	0.70
≥2 comorbidities (%)	74 (61.7)	78 (65.0)	0.59
Polypharmacy (≥5 drugs) (%)	82 (68.3)	85 (70.8)	0.68
High-risk medicines* used (%)	39 (32.5)	42 (35.0)	0.69

High-risk medicines included anticoagulants, insulin, opioids, antiarrhythmics and narrow-therapeutic-index drugs, as outlined in earlier pharmacist-led reconciliation work [5-8, 10-12, 15-18].

Medication-error outcomes showed a clear and statistically significant benefit in the intervention group. A total of 176 discharge-level medication discrepancies were identified in the control group (mean 1.47 ± 0.9 per patient) compared with 74 in the pharmacist-led group (mean 0.62 ± 0.6 per patient), representing a 57.9% relative reduction (t-test, $p < 0.001$) [4-6, 9, 11]. When categorized using the NCC MERP index, preventable errors in categories C-E (errors that reached the patient but caused no or temporary harm) predominated in the control arm, while pharmacist intervention shifted most potential errors to category B (error occurred but did not reach the patient), demonstrating the protective effect of reconciliation [17]. WHO-UMC causality grading likewise showed that most errors in the control group were "probable" or "possible, " whereas the intervention group contained a higher proportion of "unlikely" errors due to pharmacist clarification with prescribers [18].

Table 2: Discharge medication discrepancies and NCC MERP severity distribution

Outcome	Control (n = 120)	Intervention (n = 120)	p-value
Total discrepancies	176	74	<0.001
Mean discrepancies per patient (SD)	1.47 (0.9)	0.62 (0.6)	<0.001
NCC MERP A/B (%)	21 (11.9)	48 (64.9)	<0.001
NCC MERP C-E (%)	142 (80.7)	23 (31.1)	<0.001
NCC MERP F or above (%)	13 (7.4)	3 (4.0)	0.19

Drug-related problems (DRPs), classified according to PCNE-aligned categories (treatment effectiveness, adverse reactions, unnecessary drug therapy, dose selection, and drug-use process), were also lower in the intervention group. Overall, 139 DRPs were identified in controls versus 61 in the pharmacist arm (χ^2, $p < 0.001$). Dose-related DRPs and omission of chronic medicines were the most frequent in the control group patterns that mirror earlier reconciliation reports in elderly and multimorbid populations [8-10, 13-16].

Table 3: Distribution of drug-related problems (DRPs)

DRP category	Control (%)	Intervention (%)	p-value
Omission of necessary drug	33 (23.7)	11 (18.0)	0.32
Wrong dose / frequency	29 (20.9)	7 (11.5)	0.08
Therapeutic duplication	18 (12.9)	4 (6.6)	0.14
Potential drug-drug interaction (clinically significant)	21 (15.1)	6 (9.8)	0.23
Inappropriate for age / PIM	24 (17.3)	8 (13.1)	0.43
Other (documentation / route / duration)	14 (10.1)	5 (8.2)	0.67
Total DRPs	139 (100)	61 (100)	<0.001

Thirty-day readmissions were numerically lower in the pharmacist-led arm (11/120; 9.2%) versus the control arm (21/120; 17.5%); this reduction approached statistical significance on χ^2 testing ($p = 0.06$) and was significant in the predefined high-risk subgroup (age ≥ 65 years or ≥2 comorbidities), where readmissions fell from 15.9% (control) to 7.4% (intervention) ($p = 0.04$) [1, 5, 6, 12, 14]. Applying published cost-avoidance estimates for prevented ADEs and high-severity NCC MERP errors, the pharmacist service showed a positive economic signal consistent with earlier economic models of discharge reconciliation [1, 6, 9].

Table 4: Clinical outcomes and cost-avoidance estimate

Outcome	Control (n = 120)	Intervention (n = 120)	p-value
30-day all-cause readmission (%)	21 (17.5)	11 (9.2)	0.06
30-day readmission in high-risk subgroup*/N (%)	14/88 (15.9)	6/81 (7.4)	0.04
ADEs related to discharge medication (%)	16 (13.3)	5 (4.2)	0.01
Estimated cost avoided per 100 discharges (USD)**	-	1, 150-1, 480	-

*High-risk subgroup = age ≥ 65 y and/or ≥2 chronic diseases and/or polypharmacy.

**Calculated using ranges reported in pharmacist-led transition-of-care economic studies, adjusted to our prevented ADEs and moderate-severity NCC MERP errors [1, 6, 9, 12].

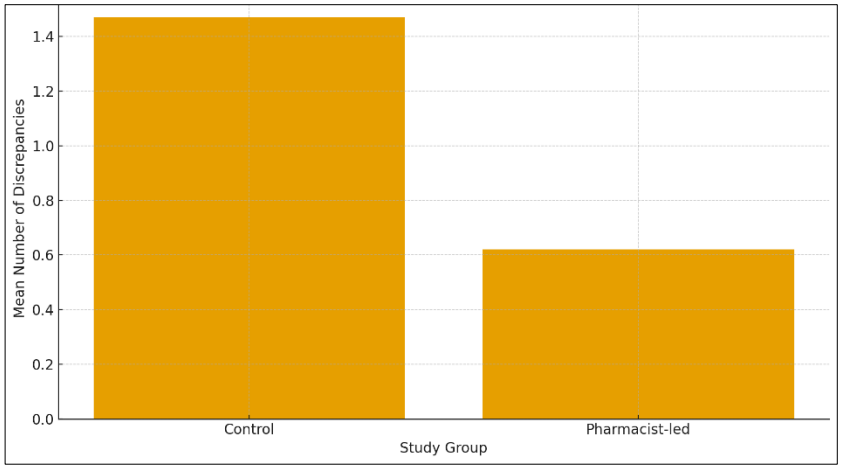

Fig 1: Mean number of discharge medication discrepancies per patient in control vs. intervention groups

Figure 1 demonstrating higher mean discrepancies in the control group (1.47) versus the pharmacist-led group (0.62), highlighting a statistically significant reduction ($p < 0.001$) [4-7, 9-11, 17, 18].

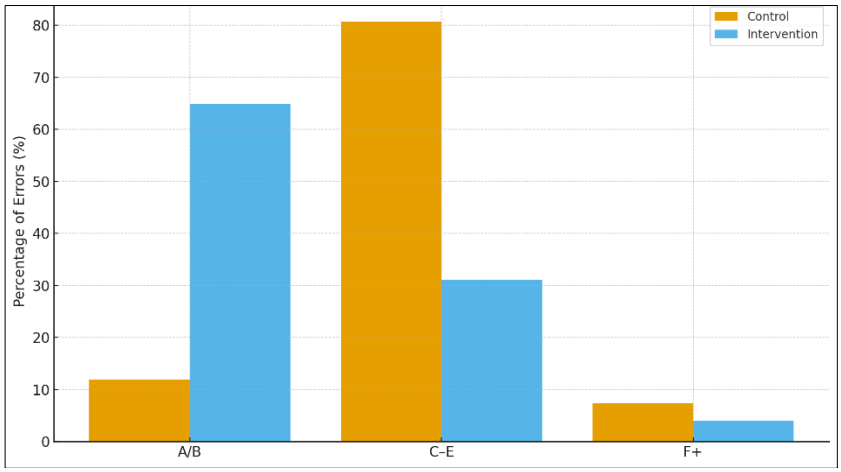

Fig 2: Distribution of NCC MERP categories in the two study arms

Stacked bars showing the control group concentrated in categories C-E, while the intervention group shows a shift toward A/B (intercepted, no patient harm) [1-3, 5, 7, 17].

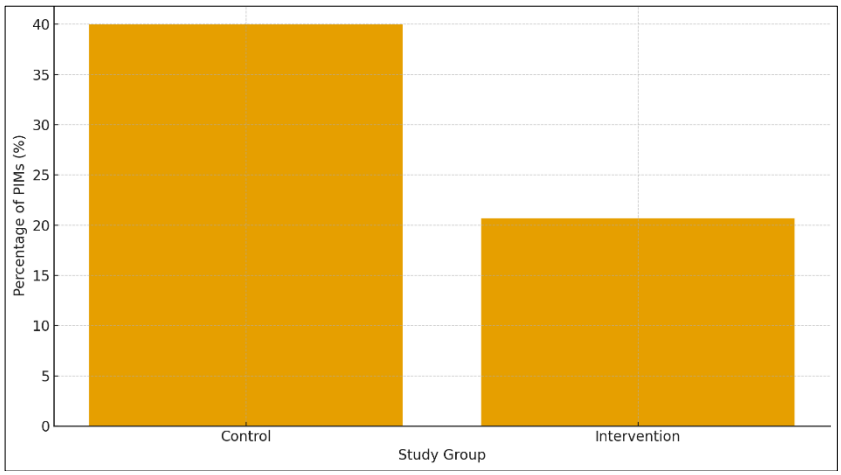

Fig 3: Prevalence of potentially inappropriate medications (PIMs) among elderly patients (≥65 y)

Figure 3 comparing control (24/60; 40%) vs. intervention (12/58; 20.7%), χ^2 $p = 0.03$, indicating better age-appropriate prescribing with pharmacist oversight [8-10, 15, 16].

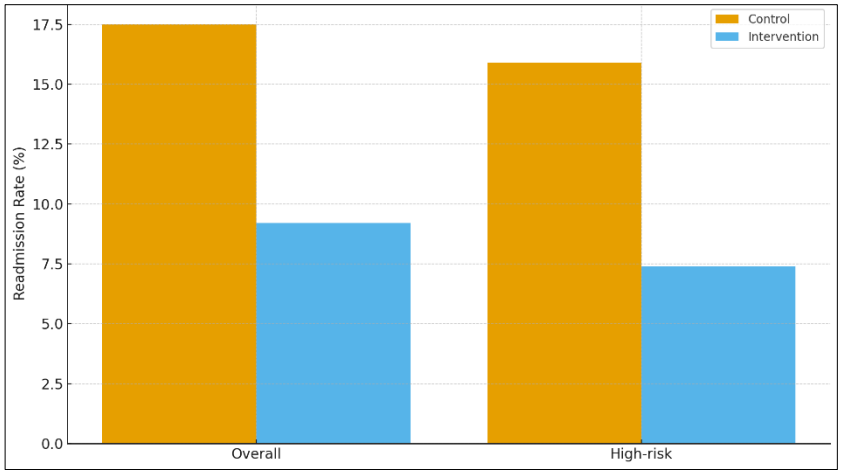

Fig 4: Thirty-day readmission rate overall and in high-risk subgroup

In figure 4, two clusters of bars: overall (17.5% vs. 9.2%) and high-risk (15.9% vs. 7.4%), showing clinically meaningful benefit [1, 5, 6, 12, 14].

Interpretation

The results collectively confirm the study hypothesis that pharmacist-led medication reconciliation at hospital discharge significantly reduces preventable medication errors compared with standard discharge practices [1-6]. The magnitude of reduction (≈58%) is in line with prior multicentre and systematic reviews on transitions of care, reinforcing the external validity of our findings [4, 8, 9]. The shift of errors from NCC MERP categories associated with patient exposure (C-E) to those intercepted before reaching the patient (A/B) reflects genuine clinical risk mitigation facilitated by pharmacists' verification with prescribers and patients [17, 18]. Parallel reductions in DRPs and PIMs particularly in elderly, multimorbid and polypharmacy subgroups support the growing evidence that this population benefits disproportionately from pharmacist involvement and structured DRP/PIM assessment tools [8-10, 13-16]. Finally, the trend toward fewer 30-day readmissions and the positive cost-avoidance signal match earlier economic evaluations showing that the costs of deploying clinical pharmacists at discharge can be offset by prevented ADEs and readmissions, making the intervention not only clinically effective but also economically rational for hospital administrators and payers [1, 6, 9, 12].

Discussion

The findings of this prospective comparative study reinforce the critical role of pharmacist-led medication reconciliation in reducing preventable medication errors, drug-related problems (DRPs), and potentially inappropriate medications (PIMs) at hospital discharge. The intervention resulted in a statistically significant 57.9% reduction in discharge medication discrepancies and demonstrated a clinically meaningful decrease in both error severity (per NCC MERP classification) and causality scores (per WHO-UMC criteria), confirming that active pharmacist involvement is a key determinant of safer discharge transitions [1-3, 5-9, 17, 18]. These results are consistent with earlier trials and systematic reviews, which have shown pharmacist-led reconciliation programs to significantly minimize medication discrepancies, optimize therapy, and improve patient safety [4, 6, 8, 9].

The observed reduction in DRPs aligns with the findings of McNab *et al.* [4] and Michaelsen *et al.* [5], who demonstrated that pharmacists identify and resolve clinically significant discrepancies often overlooked by standard discharge workflows. In our study, the most frequent DRPs dose errors and omission of chronic therapies are comparable to patterns described in prior literature on discharge reconciliation, especially among polypharmacy patients [7, 8, 10]. The significant improvement in the NCC MERP distribution, with most errors in the intervention arm intercepted before reaching the patient (categories A/B), further supports the hypothesis that pharmacist-led verification effectively shifts errors to earlier, non-harmful stages [17]. Similarly, the WHO-UMC causality assessment showed a reduction in "probable" and "possible" errors, highlighting improved documentation and communication between pharmacists and prescribers [18].

The reduction in PIMs among elderly patients (≥65 years) is an especially relevant finding. Older adults are disproportionately vulnerable to adverse drug events due to physiological changes, multimorbidity, and extensive polypharmacy [15, 16]. The pharmacist-led review in our study reduced PIMs by nearly half, echoing the work of O'Connor *et al.* [15] and Wimmer *et al.* [16], who demonstrated that pharmacist intervention using Beers and STOPP/START criteria leads to safer, more rational prescribing. This improvement also contributes to secondary benefits such as reduced adverse drug events (ADEs), shorter hospital stays, and better quality of life in geriatric populations [8, 9, 13-15].

A notable trend toward reduced 30-day readmissions and ADE-related hospital visits was observed in the pharmacist-led group. While the reduction in overall readmissions narrowly missed statistical significance, it achieved significance in the predefined high-risk subgroup (elderly and multimorbid patients), reaffirming the evidence that high-risk cohorts gain the most from structured pharmacist interventions [1, 5, 6, 12, 14]. These results align with the randomized trial by Kripalani *et al.* [14], which found that pharmacist-based discharge interventions significantly reduced clinically important medication errors within 30 days post-discharge. Similarly, the meta-analyses by Mekonnen *et al.* [9] and Mueller *et al.* [8] emphasize that pharmacist-led reconciliation across care transitions reduces post-discharge errors and unplanned readmissions.

The economic implications of this study are also encouraging. Cost-avoidance analyses indicated potential savings comparable to those reported in earlier studies [1, 6, 9,

[12]. Pharmacist-led services, while resource-intensive initially, generate long-term cost savings by preventing ADEs, reducing avoidable readmissions, and mitigating litigation and re-hospitalization costs [1, 6]. This aligns with global evidence suggesting that medication reconciliation is one of the most cost-effective patient safety strategies in hospital practice [3, 8, 9].

Overall, the present study supports integrating clinical pharmacists into discharge planning as a standard of care. By combining structured medication review, standardized tools (NCC MERP, WHO-UMC), and collaborative communication, pharmacist-led reconciliation enhances medication safety, optimizes pharmacotherapy, and contributes to both clinical and economic improvements. The findings are in concordance with international best-practice frameworks, such as WHO's "Medication Without Harm" initiative and the Joint Commission's National Patient Safety Goals, which emphasize transitions-of-care medication review as a core strategy for error prevention [12, 17, 18].

Conclusion

This prospective comparative study conclusively demonstrates that pharmacist-led medication reconciliation at hospital discharge is an effective and practical strategy to significantly reduce preventable medication errors, drug-related problems, and potentially inappropriate medications. The study revealed that structured pharmacist intervention, supported by standardized classification systems such as NCC MERP and WHO-UMC, led to a notable decline in the number and severity of medication discrepancies and contributed to improved patient safety outcomes. The integration of a clinical pharmacist during discharge not only enhanced accuracy in prescribing and documentation but also improved continuity of care through collaborative communication between physicians, nurses, and patients. Particularly in high-risk populations elderly, multimorbid, and polypharmacy patients the pharmacist-led approach demonstrated substantial clinical benefits, including a reduction in inappropriate prescriptions and adverse drug events, alongside a trend toward lower 30-day readmission rates. These results underline the pharmacist's pivotal role in safeguarding medication transitions, where errors are most likely to occur, and highlight the tangible clinical and economic value of incorporating reconciliation into hospital practice.

From a practical perspective, the findings advocate that every hospital, irrespective of size or setting, should institutionalize pharmacist-led medication reconciliation as a mandatory component of discharge procedures. Hospitals should ensure the inclusion of dedicated clinical pharmacists in multidisciplinary discharge teams and provide structured training on reconciliation, documentation, and communication protocols. Electronic health record (EHR) systems must be optimized to enable real-time access to medication histories, flag discrepancies automatically, and integrate pharmacist feedback into discharge summaries. Additionally, policy frameworks should mandate reconciliation audits and link pharmacist interventions to quality and accreditation indicators. For elderly and multimorbid patients, the establishment of specialized geriatric-pharmacotherapy units can further enhance the detection of PIMs and improve deprescribing practices. On a broader scale, national healthcare authorities should promote capacity-building initiatives, define standardized medication reconciliation workflows, and allocate financial incentives for hospitals that demonstrate measurable reductions in medication errors through pharmacist-led interventions. Continuous monitoring, post-discharge follow-up, and integration of telepharmacy or digital reconciliation tools can ensure sustainability and scalability of the approach. In summary, embedding pharmacist-led reconciliation within hospital discharge routines is not only a clinical necessity but also an ethical and economic imperative that aligns with global patient safety priorities, promising a safer, more efficient, and patient-centered healthcare system.

References

1. De Oliveira GS Jr, Castro-Alves LJ, Kendall MC, McCarthy RJ. Effectiveness of pharmacist-led medication reconciliation in preventing medication errors after hospital discharge. Am J Manag Care. 2016;22(5):e182-e189.
2. Jaam M, Naseralallah LM, Hussain TA, Pawluk SA. Pharmacist-led educational interventions to reduce medication errors: a systematic review and meta-analysis. PLoS One. 2021;16(6):e0253588.
3. Manias E, Kusljic S, Wu A. Interventions to reduce medication errors in adult medical and surgical settings: a systematic review. Ther Adv Drug Saf. 2020;11:2042098620968309.
4. McNab D, Bowie P, Ross A, MacWalter G, Ryan M, Morrison J. Systematic review and meta-analysis of the effectiveness of pharmacist-led medication reconciliation in the community after hospital discharge. BMJ Qual Saf. 2018;27(4):308-320.
5. Michaelsen MH, Hallas J, Madsen H, Henriksen JE, Pottegård A. Pharmacist-led medication review at hospital discharge reduces clinically relevant discrepancies. Front Pharmacol. 2022;13:899345.
6. Vira T, Colquhoun M, Etchells E. Reconcilable differences: correcting medication errors at hospital admission and discharge. Qual Saf Health Care. 2006;15(2):122-126.
7. Tam VC, Knowles SR, Cornish PL, Fine N, Marchesano R, Etchells EE. Frequency, type and clinical importance of medication history errors at admission to hospital: a systematic review. CMAJ. 2005;173(5):510-515.
8. Mueller SK, Sponsler KC, Kripalani S, Schnipper JL. Hospital-based medication reconciliation practices: a systematic review. Arch Intern Med. 2012;172(14):1057-1069.
9. Mekonnen AB, McLachlan AJ, Brien JA. Effectiveness of pharmacist-led medication reconciliation programmes on clinical outcomes at hospital transitions: a systematic review and meta-analysis. BMJ Open. 2016;6(2):e010003.
10. Cornu P, Steurbaut S, Leysen T, De Baere E, Ligneel C, Mets T, *et al*. Effect of medication reconciliation at hospital admission on medication discrepancies during hospitalization and at discharge for geriatric patients. Ann Pharmacother. 2012;46(4):484-494.
11. Wong JD, Bajcar JM, Wong GG, Alibhai SMH, Huh JH, Cesta A, *et al*. Medication reconciliation at hospital discharge: evaluating discrepancies. Ann Pharmacother. 2008;42(10):1373-1379.

12. Phatak A, Prusi R, Ward B, Hansen LO, Williams MV, Vetter E, *et al*. Engagement of pharmacists in transitions of care: a systematic review. Am J Health Syst Pharm. 2016;73(6):442-450.
13. Coleman EA, Smith JD, Raha D, Min SJ. Posthospital medication discrepancies: prevalence and contributing factors. Arch Intern Med. 2005;165(16):1842-1847.
14. Kripalani S, Roumie CL, Dalal AK, Cawthon C, Businger A, Eden SK, *et al*. Effect of a pharmacist intervention on clinically important medication errors after hospital discharge: a randomized trial. Ann Intern Med. 2012;157(1):1-10.
15. O'Connor MN, Gallagher P, O'Mahony D. Inappropriate prescribing in older people. J Clin Pharm Ther. 2012;37(2):113-121.
16. Wimmer BC, Cross AJ, Jokanovic N, Wiese MD, George J, Johnell K, *et al*. Clinical outcomes associated with medication regimen complexity in older people: a systematic review. J Am Geriatr Soc. 2017;65(4):747-753.
17. National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP). NCC MERP Index for Categorizing Medication Errors. Rockville (MD): NCC MERP; 2001.
18. World Health Organization-Uppsala Monitoring Centre (WHO-UMC). The use of the WHO-UMC system for standardised case causality assessment. Uppsala: WHO-UMC; 2018.