

Integrated drug management for elderly patients with congestive heart failure: enhancing medication accuracy using the MINE (Medicine IN gEriatric) application

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ABSTRACT

Background This study evaluated the impact of the Medicine IN Geriatric (MINE) application, which integrates the Integrated Medicine Management (IMM) model and STOPP/START criteria, on improving prescribing practices in elderly patients with congestive heart failure (CHF).

Methods A two-phase study was conducted: validation of the IMM model and its implementation via the MINE app. A quasi-experimental pretest-posttest control group design was used in a hospital in East Kalimantan, Indonesia. Patients aged 60–79 years were randomly assigned to the intervention or control group. The intervention group received IMM-based pharmaceutical services, including medication reconciliation, repeated medication reviews, and individualized discharge counseling. The outcomes assessed included polypharmacy rates, potentially inappropriate medications (PIMs), potential prescribing omissions (PPOs), and health-related quality of life, using the EQ-5D-5L and EQ-VAS tools.

Results Expert validation showed high content validity, with I-CVI ≥ 0.86 and S-CVI = 0.94. During implementation, the use of antiplatelets, statins, angiotensin converting enzyme inhibitors (ACEI), and angiotensin receptor β -blockers (ARB) declined from admission to discharge. PIMs, such as beta-blockers in patients with conduction disorders and ACE-I/ARBs in those with hyperkalemia, also decreased. The intervention group's EQ-5D-5L scores improved from 0.552 to 0.664, whereas the control group's scores declined slightly. EQ-VAS scores also increased significantly in the intervention group.

Conclusion The MINE-based IMM intervention effectively reduced inappropriate prescribing and enhanced the quality of life in elderly patients with CHF. This technology-enabled multidisciplinary approach supports safer prescribing in geriatric care.

Heart failure (HF) is a clinical condition that affects approximately 2% of the general population, with a notably higher prevalence in older adults. In individuals aged ≥ 80 years, the prevalence reaches approximately 11% in men and 14% in women.^[1–3] Advances in heart failure management have led to increased survival, and the overall aging population is a factor that likely contributes to the persistent or even gradually rising prevalence of HF observed over time.^[4–6] Polypharmacy is defined as the

simultaneous administration of multiple pharmacological agents. While a universally standardized definition is absent, the most widely endorsed interpretation among scholars is the habitual consumption of five or more medicinal substances. This encompasses not only prescribed pharmaceutical but also over-the-counter preparations and traditional and complementary remedies employed by the patient.^[7] Older adults exhibit heightened susceptibility to polypharmacy owing to the ubiquity of chronic morbidities, involvement of multiple

prescribers, and concurrent pharmacotherapeutic regimens. This confluence of factors may undermine physiological resilience, precipitate adverse drug reactions, pharmacokinetic and pharmacodynamic interactions, therapeutic noncompliance, increased rates of hospitalization, systemic dysregulation, and ultimately, an elevated mortality risk.^[8] In scenarios where polypharmacy is ineluctable, the principal challenge lies in ensuring the judicious and evidence-informed utilization of pharmacological agents, particularly among older adults with multimorbidity. The coexistence of multiple chronic conditions and extensive pharmacological regimens, compounded by age-related alterations in pharmacokinetics and pharmacodynamics, markedly augments susceptibility to adverse drug events and perilous pharmacologic interactions, with risk elevations approaching 30%.^[9-11] Consequently, vigilant surveillance of pharmacological prescriptions and the pursuit of rational drug deployment in this demographic are of paramount importance. Prudent and context-sensitive prescribing necessitates heightened attentiveness from healthcare professionals, particularly in addressing the novel age-specific and age-integrated complexities of the geriatric population. This entails the implementation of rigorously defined prescribing protocols and the advancement of educational initiatives for patients and medical practitioners to cultivate informed and judicious pharmacotherapy.^[11,12]

To enhance the prescribing efficacy in the geriatric population, the Screening Tool of Older Persons' Prescriptions (STOPP) and the Screening Tool to Alert to Right Treatment (START) criteria were developed. The initial iteration was conceived as a pragmatic, time-efficient instrument for clinicians, enabling the systematic evaluation of pharmacological regimens in older adults by contextualizing prescribed medications within the framework of their coexisting medical conditions.^[13] In 2015, a revised second version of the STOPP/START criteria was introduced.^[14] Since its inception, this tool has been increasingly utilized in scholarly investigations to scrutinize and characterize the pharmacotherapeutic profiles of older adult populations.^[15,16] In recent years, medical professionals have increasingly focused on identifying and implementing individualized, evidence-based prescribing frameworks. Explicit prescribing criteria have been established as evidence-based clinical instruments to facilitate the identification of potentially inappropriate medication use and to minimize adverse

drug-related outcomes in geriatric populations, with the ultimate aim of optimizing the safety, efficacy, and appropriateness of pharmacological therapy among older adults.^[17] The STOPP component identifies medications that may be inappropriate or potentially harmful, whereas the START component highlights clinically indicated treatments that have been omitted, thereby enhancing pharmacotherapeutic efficacy and reducing the likelihood of adverse outcomes in older adults. The STOPP/START criteria are applicable to both inpatient and ambulatory care settings.^[18,19] Integrated medicine management (IMM) is a structured and comprehensive strategy aimed at optimizing and personalizing pharmacotherapy across the continuum of inpatient care in hospitals. IMM encompasses a tripartite process that aligns with the principal phases of a patient's hospitalization: medication reconciliation upon admission, systematic medication review during hospitalization, and provision of comprehensive pharmacological information at discharge.^[20] Incorporating the STOPP/START criteria into the Medicine in Geriatrics (MINE) application may enhance the identification of potentially inappropriate prescriptions (PIP). Notably, previous investigations evaluating the utility of medication review software grounded in clinical frameworks, such as STOPP/START, have substantiated the high detection rate of inappropriate prescriptions in older adults. However, evidence indicates that a substantial proportion of drug-related problems (DRPs) identified during medication reviews fall outside the purview of STOPP/START criteria. Collectively, these findings imply that reliance solely on the STOPP/START framework is insufficient to capture the full spectrum of pharmacotherapeutic discrepancies. Consequently, a more nuanced and multifaceted approach encompassing structured assessments, patient interviews to elicit health and medication-related concerns, and expert evaluation by trained healthcare practitioners is warranted to optimize the detection and resolution of clinically significant DRPs.

METHODS

Study Design

This study employed a quasi-experimental design conducted at the inpatient unit of RSUD Abdoel Wahab Sjahranie Samarinda from April 2022 to June 2023. Val-



idation of IMM model in Geriatric Congestive Heart Failure patients and socialization of Integrated Medicine Management model with MINE application. The content validity of the Integrated Medicine Management model was assessed, which was developed based on drug-related problem data existing in geriatric patients with CHF, to ensure that each component of the model is relevant, feasible, and applicable. This study used quantitative content validation with the Content Validity Index (CVI) approach. The assessment was conducted by health professionals. The intervention of the integrated medicine management model was specifically conducted in the internal medicine ward of a hospital in East Kalimantan, Indonesia, with hospitalized geriatric heart failure patients using a quasi-experimental method with a pre-test-post-test control group design.

Setting and Participants

The target sample consisted of geriatric patients aged 60–79 years with congestive heart failure (CHF), who were hospitalized for at least 24 h and had been diagnosed with CHF for at least one year. The minimum required sample size (n), calculated using the formula by Lameshow, *et al.*^[21] was determined to be 80 participants for each group (intervention and control groups). This calculation ensured that the study had sufficient statistical power (at 95% significance level, $Z_{1-\alpha} = 1.96$; and 95% power, $Z_{1-\beta} = 0.84$) to detect a significant difference ($\mu_1 - \mu_2$) between the two groups. The final figure (80 per group) was deemed a practical sample that adequately represented the target population. Therefore, the $n = 80$ sample size is statistically sufficient to represent the patient population at the study site and provides reliable data to address the established research hypotheses and objectives. Patient recruitment utilized consecutive sampling (a non-probability method). Eligible individuals ($n = 176$), following informed consent, were recruited sequentially and subsequently allocated sequentially based on the time of recruitment (rather than randomly) into either group. This non-random allocation was necessary due to operational constraints, though it represents a potential limitation for controlling all confounding factors. To mitigate potential selection bias stemming from the non-random allocation, strict adherence to the predetermined inclusion criteria was maintained by all researchers involved in the recruitment process. The intervention cohort received care from a multidisciplinary team, including clinical pharmacists, during hospitaliz-

ation. The pharmacist was responsible for conducting medication reconciliation and review upon admission, performing ongoing medication evaluations throughout the hospital stay, and executing reconciliation and individualized discharge counseling in accordance with the Integrated Medicines Management (IMM) framework.^[14] Medication reviews were repeated as clinically indicated based on alterations in prescriptions, patient-reported symptoms, evolving clinical conditions, and laboratory findings.

$$n = \frac{2\sigma^2 \left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta} \right)^2}{(\mu_1 - \mu_2)^2}$$

Intervention and Data Collection

Three clinical pharmacists, two physicians in charge, and three nurses performed the intervention and collected data during the study period. Each participant held a master's degree in clinical pharmacy and had undergone standardized IMM training prior to the study. The intervention was implemented using uniform IMM protocols that were specifically adapted to the hospital's environment. Furthermore, the IMM implementation was conducted through three integrated stages: admission, hospital care, and discharge planning, with the active involvement of the Attending Physician (DPJP), clinical pharmacist, and nurse as a form of interprofessional collaboration. This entire IMM intervention process was carried out using the MINE application, which facilitates real-time medication reconciliation, review, and interprofessional collaboration. A detailed functional description, including the workflow and key modules of the MINE application, is visually illustrated in Figure 1. In contrast, the control group received conventional care from physicians specializing in internal medicine and nursing. However, this group did not receive structured IMM services or interventions from clinical pharmacists. The study was conducted while the patient was hospitalized, and discharge planning was provided in the form of educational videos and a medication list before discharge. The patients' quality of life was assessed using the EQ-5D-5L, a comprehensive and internationally validated instrument for measuring health-related quality of life in geriatric populations. This tool evaluates five key dimensions—mobility, self-care, usual activities, pain or discomfort, and anxiety or depression—and converts these responses into a single utility value ran-



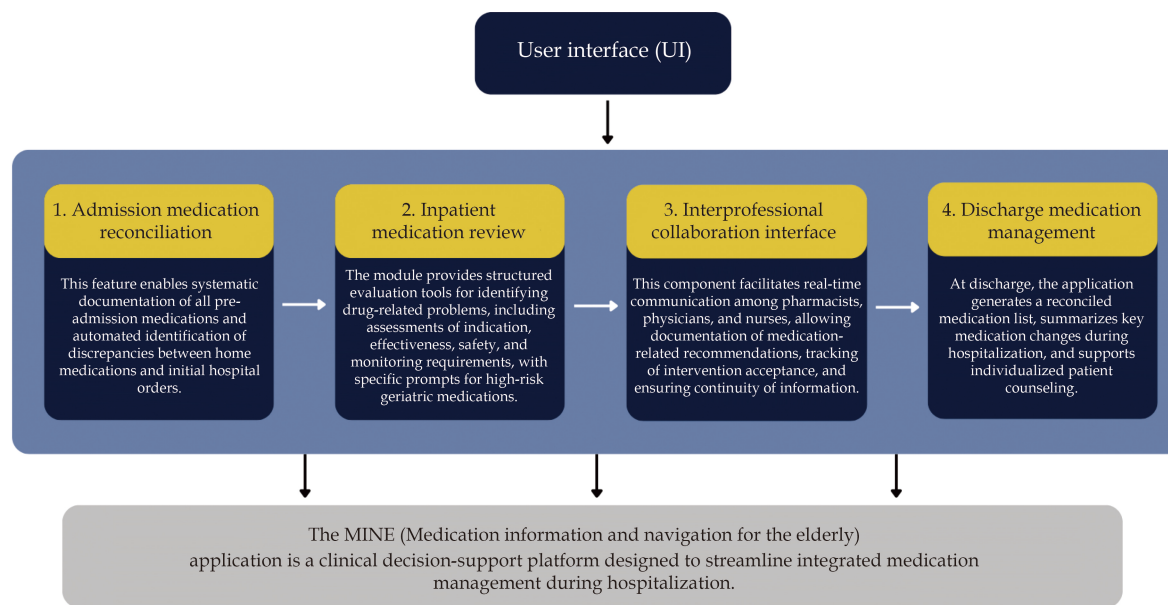


Figure 1 MINE application functional components diagram.

ging from < 0 (worse than death) to 1 (perfect health), providing an overall measure of the patients' well-being throughout the study period.^[22] In addition, repeated hospitalizations were recorded for three months.

Data Analysis

Prior to conducting any analysis, the data were manually cleaned to ensure their accuracy and consistency. For inferential statistics, data distribution normality was assessed using the Kolmogorov-Smirnov test, and homogeneity was checked using the Levene Test. If data were found to be both normally distributed and homogeneous, subsequent parametric statistical tests were performed. Conversely, if data were either normally distributed but non-homogeneous, or non-normally distributed and non-homogeneous, then non-parametric statistical tests were applied. Specifically, the Paired Sample *t*-test (parametric) or Wilcoxon test (non-parametric) was utilized to assess differences before and after treatment within each sample group, while the Independent Sample *t*-test (parametric) or Mann Whitney test (non-parametric) was used to compare differences between the control and intervention groups. Descriptive statistical methods were also employed to elucidate the incidence of polypharmacy (defined as taking five or more medications), the quantum of pharmacotherapeutic perturbations delineated via the STOPP/START criteria, the corresponding recommendations conveyed, and the proportion of patients receiving prescriptions in-

volving Potentially Inappropriate Medications (PIMs, where STOPP triggers are PIMs) and/or Potential Prescribing Omissions (PPOs, where START triggers are PPOs). Statistical evaluation was performed using Microsoft Excel®, and all derivations were adjusted for cases excluded due to attrition.

RESULTS

This study introduces a novel application of the Integrated Medicine Management (IMM) model in geriatric patients with congestive heart failure (CHF), particularly through the development of the MINE (Medicine IN gEriatric) digital platform. This system serves as a documentation and interprofessional communication tool to support the identification and resolution of Drug-Related Problems (DRPs) during hospitalization.

Table 1 shows the baseline characteristics of the patients in the control and intervention groups. Both groups were predominantly male and classified as young elderly (60–69 years old). Most patients received 5–10 medications and had more than three comorbidities each. The length of stay was generally 5–10 days. All patients in the intervention group showed improvement, whereas one patient in the control group was discharged against medical advice. The 95% CI for all measured baseline variables confirmed that no statistically significant differences were observed between the groups ($P > 0.05$).

At admission, PPO was most prevalent in the use of

Table 1 Patient characteristics.

Patient characteristics	Control group	Intervention group	P-value	95% CI
Sex			0.203	0.253–1.067
Male	54 (67.5%)	64 (80.0%)		
Female	26 (32.5%)	16 (21.0%)		
Age			0.524	0.044–5.556
Young elderly (60–69 yrs)	78 (97.5%)	79 (98.8%)		
Middle Elderly (70–79 yrs)	2 (2.5%)	1 (1.3%)		
Number of drug therapies			0.334	0.211–2.290
< 5	5 (93.8%)	7 (91.3%)		
≥ 5	75 (6.2%)	73 (8.8%)		
Comorbidities in CHF patients				
1	8(10.0%)	6(7.5%)		
2–3	21 (26.3%)	17 (21.2%)		
>3	51 (63.8%)	57 (71.3%)		
Length of hospital stay			0.633	0.265–1.836
< 5 days	8 (10.0%)	11 (13.8%)		
5–10 days	72 (90.0%)	69 (96.3%)		
Hospitalization outcome				
Improved	79 (98.8%)	80 (100.0%)		
Discharged against medical advice	1 (1.3%)	0		

Data are presented as *n* (%). CHF: congestive heart failure. *P*-values were derived from the Chi-square or Fisher's exact test. A *P*-value > 0.05 indicates no statistically significant difference in baseline characteristics between the two groups.

antiplatelet therapy (13.75%), which then decreased to 6.25% upon discharge (Table 2). PPO related to the use of statins also decreased significantly, from 10% at admission to 1.25% at discharge. Similarly, the use of angiotensin-converting enzyme inhibitors (ACEI) decreased from 7.5% at admission to 3.75% at discharge. Meanwhile, the PPO on appropriate beta-blocker use was recorded at 3.75% at admission and decreased to 1.25% at discharge. These findings suggest improved ad-

herence to the START criteria during hospitalization, especially after the intervention

AS shown in Table 3, based on the analysis of the use of PIM in geriatric patients with congestive heart failure according to the STOPP-2 criteria, it was found that there was a decrease in the number of PIM from admission to discharge in the intervention group. At the time of admission, the use of beta-blocker drugs in patients with bradycardia or certain types of AV block was recorded at

Table 2 PPO usage in geriatric patients with congestive heart failure at admission and discharge at AWS General Hospital Samarinda.

PPO type based on START criteria	Intervention Group	
	Admission	Discharge
Administration of antiplatelet agents (such as aspirin, prasugrel, or ticagrelor) is indicated for individuals with a documented history of peripheral arterial disease, cerebrovascular events, or coronary artery disease.	11 (13.75%)	5 (6.3%)
Statin therapy in patients with a history of peripheral vascular disease, cerebrovascular disease, and coronary disease, except in patients in end-of-life status or aged ≥85 years.	8 (10.0%)	1 (1.3%)
ACEI in patients with systolic heart failure and/or coronary artery disease.	6 (7.5%)	3 (3.8%)
Appropriate beta-blockers (bisoprolol, nebivolol, metoprolol, or carvedilol) in patients with stable systolic heart failure.	3 (3.8%)	1 (1.3%)

Data are presented as *n* (%). ACE inhibitors: angiotensin-converting enzyme inhibitors; PPO: potential prescribing omission; START Criteria: screening tool of alerts to right treatment.



Table 3 PIM usage in geriatric congestive heart failure patients at admission and discharge at AWS General Hospital Samarinda.

PIM type based on STOPP-2 criteria	Intervention group	
	Admission	Discharge
Beta-blockers in patients with bradycardia (< 50 beats/min), AV block Type II, or complete AV block (increased risk of heart block).	15 (18.8%)	8 (10.0%)
Use of angiotensin-converting enzyme inhibitors or angiotensin receptor antagonists in individuals presenting with hyperkalemia (risk of worsening hyperkalemia).	12 (15.0%)	5 (6.3%)
Aspirin use without concomitant PPI (proton pump inhibitor) in patients with a history of peptic ulcers (risk of peptic ulcer recurrence).	7 (8.8%)	2 (2.5%)

Data are presented as *n* (%). PIM is defined based on the STOPP-2 criteria. The figures in the Intervention Group columns reflect the number of patients administered (Admission) or discontinued/switched (Discharge) PIM, followed by the percentage relative to the total patients in the intervention group (*n* = 80). PIM: potentially inappropriate medication.

18.75%, which then decreased to 10% upon discharge. The use of ACE inhibitors in patients with hyperkalemia was also reduced from 15% to 6.25%. In addition, the use of aspirin without PPI in patients with a history of peptic ulcer was recorded in 8.75% of patients at admission and decreased to 2.5% at the time of discharge.

At the admission stage, there was a significant decrease in the number of medication errors, as shown in Table 4. Medication errors, such as incomplete drug history (from 47.5% to 15%), duplication of therapy (from 37.5% to 10%), and use of inappropriate drugs (from 35% to 7.5%), decreased significantly post-intervention. There was a significant decrease in the identification of drug history, detection of duplication, and use of inappropriate drugs since the intervention. During the hospital care stage, there were significant decreases in laboratory monitoring (from 40% to 12.5%), unmanaged drug interactions (from 32.5% to 11.3%), and STOPP/START implementation (from 100% to only 6.25%). At the discharge stage, errors such as no medication education (100% to 7.5%), absence of a medication list (100% to 5%),

and no medication reconciliation (41.25% to 6.25%) showed a significant decline.

The difference in repeated hospitalizations between the two groups was also significant, with a *Z* value of -2.478 (*Z* = -2.478; *P* = 0.013; 95% CI: -0.265–0.265). This finding suggests that the intervention has the potential to reduce the length of hospitalization and the frequency of repeated hospitalizations in patients (Table 5). The statistical test results in Table 6 showed that several dimensions experienced significant differences between the control and intervention groups after the intervention, such as pain/discomfort (*Z* = -6.386; *P* = 0.000) and depression/anxiety (*Z* = -3.650; *P* = 0.000). This illustrates that the intervention provided contributes positively to improving the quality of life of geriatric patients with congestive heart failure, especially in reducing pain and anxiety. As shown in Table 7, the QoL index score of geriatric patients with congestive heart failure, measured by EQ-5D-5L, improved substantially more in the intervention group than in the control group. These data suggest that the intervention contributed positively to

Table 4 Medication error reduction based on IMM stages checklist.

Stage IMM	Category	Control (<i>n</i> = 80)	Intervention IMM (<i>n</i> = 80)	Decrease (%)
Admission	Incomplete drug history	38 (47.5%)	12 (15.0%)	68.4
	Duplication of therapy detected	30 (37.5%)	8 (10.0%)	73.3
	Medication is not appropriate for the diagnosis	28 (35.0%)	6 (7.5%)	78.6
Hospital Care	Risk drug monitoring is not done	32 (40.0%)	10 (12.5%)	68.8
	Significant drug interaction untreated	26 (32.5%)	9 (11.3%)	65.4
	STOPP/START not implemented	80 (100.0%)	5 (6.3%)	93.8
Discharge	Medication education not provided	80 (100.0%)	6 (7.5%)	92.5
	No medication list	80 (100.0%)	4 (5.0%)	95.0
	Medication reconciliation is not performed	33 (41.3%)	5 (6.3%)	84.8

Data are presented as *n* (%) unless other indicated. IMM: integrated medication management. Figures in the control and intervention group columns indicate the frequency of error findings (admission, hospital care) or implementation failure (discharge).



Table 5 Outcome reduction from admission to discharge.

Variable	Control Group	Intervention Group	Z (P-value)	95% CI
Length of hospital stay				
< 5 days	28 (33.0%)	58 (72.5%)	-4.742 (0.000)	0.230-0.520
≥ 5 days	52 (65.0%)	22 (27.5%)		
Readmission in 3 months				
1x	32 (40%)	50 (62.5%)	-2.478 (0.013)	-0.265-0.265
2x	38 (47.5%)	12 (15.0%)		
3x	9 (11.3%)	13 (16.3%)		
4x	0 (0.0%)	1 (1.3%)		

Data are presented as *n* (%). The Z and P values are derived from a statistical test (likely a Z-test for proportions or another non-parametric test) comparing proportions between the Control and Intervention Groups. *P* < 0.05 is considered statistically significant.

Table 6 The quality of life of geriatric patients in control and intervention group.

Dimension EQ-5D	Level	Control Group	Intervention Group	Z (P-value)
Mobility (pre)	No problems	35 (43.8%)	42 (52.5%)	-1.284 (0.199)
	Slight problems	21 (26.3%)	18 (22.5%)	
	Moderate problems	8 (10.0%)	10 (12.5%)	
	Severe problems	11 (13.8%)	10 (12.5%)	
	Unable/Extreme problems	5 (6.3%)	0	
Selfcare (pre)	No problems	46 (57.5%)	46 (57.5%)	-0.023 (0.982)
	Slight problems	13 (16.3%)	13 (16.3%)	
	Moderate problems	12 (15.0%)	13 (16.3%)	
	Severe problems	9 (11.3%)	7 (8.8%)	
	Unable/Extreme problems	0	1 (1.3%)	
Usual activities (pre)	No problems	34 (42.5%)	41 (51.3%)	-1.041 (0.298)
	Slight problems	24 (30.0%)	19 (23.8%)	
	Moderate problems	10 (12.5%)	12 (15.0%)	
	Severe problems	11 (13.8%)	8 (10.0%)	
	Unable/Extreme problems	1 (1.3%)	0	
Pain/Discomfort (pre)	No problems	0	0	-1.136 (0.256)
	Slight problems	35 (43.8%)	42 (52.5%)	
	Moderate problems	20 (25.0%)	18 (22.5%)	
	Severe problems	17 (21.3%)	14 (17.5%)	
	Unable/Extreme problems	8 (10.0%)	6 (7.5%)	
Anxiety/Depression (pre)	No problems	33 (41.3%)	47 (58.8%)	-2.649 (0.008)
	Slight problems	24 (30.0%)	22 (27.5%)	
	Moderate problems	15 (18.8%)	10 (12.5%)	
	Severe problems	6 (7.5%)	1 (1.3%)	
	Unable/Extreme problems	2 (2.5%)	0	
Mobility (post)	No problems	18 (22.5%)	36 (45.0%)	-3.585 (0.000)
	Slight problems	33 (41.3%)	30 (37.5%)	
	Moderate problems	12 (15.0%)	10 (12.5%)	
	Severe problems	12 (15.0%)	4 (5.0%)	
	Unable/Extreme problems	5 (6.3%)	0	



Continued

Dimension EQ-5D	Level	Control Group	Intervention Group	Z (P-value)
Selfcare (post)	No problems	34 (42.5%)	47 (58.8%)	-2.038 (0.042)
	Slighth problems	22 (27.5%)	17 (21.3%)	
	Moderate problems	14 (17.5%)	10 (12.5%)	
	Severe problems	10 (12.5%)	5 (6.3%)	
	Unable/Extreme problems	0	1 (1.3%)	
Usual Activities (post)	No problems	34 (42.5%)	42 (52.5%)	-1.257 (0.209)
	Slighth problems	22 (27.5%)	18 (22.5%)	
	Moderate problems	12 (15.0%)	12 (15.0%)	
	Severe problems	11 (13.8%)	8 (10.0%)	
	Unable/Extreme problems	1 (1.3%)	0 (0.0%)	
Pain/Discomfort (post)	No problems	4 (5.0%)	19 (23.8%)	-6.386 (0.000)
	Slighth problems	14 (17.5%)	39 (48.8%)	
	Moderate problems	26 (32.5%)	13 (16.3%)	
	Severe problems	23 (28.8%)	8 (10.0%)	
	Unable/Extreme problems	13 (16.3%)	1 (1.3%)	
Anxiety/Depression (post)	No problems	28 (35.0%)	50 (62.5%)	-3.650 (0.000)
	Slighth problems	35 (43.8%)	23 (28.8%)	
	Moderate problems	10 (12.5%)	7 (8.8%)	
	Severe problems	6 (7.5%)	0	
	Unable/Extreme problems	1 (1.3%)	0	

Data are presented as *n* (%). The Z and P-values are derived from a statistical test (likely a Z-test for proportions or another non-parametric test) comparing proportions between the Control and Intervention Groups. A P value of < 0.05 is considered statistically significant.

Table 7 The quality of life of geriatric congestive heart failure patients (EQ-5D-5L).

EQ-5D-5L	Pre-test control	Post-test control	Pre-test intervention	Post-test intervention
Mean	0.484	0.430	0.552	0.664
Minimum	-0.439	-0.510	-0.407	-0.291
Maximum	0.914	0.921	0.914	1,000

The EQ-5D-5L (EuroQol 5-Dimension 5-Level) is a standardized instrument used to measure health-related quality of life across five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Index scores (Mean) range from negative values (representing health states perceived as worse than death) to 1.000 (perfect health).

improving specific measured aspects of the quality of life of geriatric patients with congestive heart failure compared to the control group, which did not receive a similar intervention.

As shown in Table 8, statistical tests showed no significant difference between the two groups before the intervention ($P = 0.408$; 95% CI: -2.246–5.497). However, a more striking difference was observed in the post-intervention measurements (*post-test*). The lowest VAS score in the control group remained at 30, whereas it increased to 50 in the intervention group. The highest score also increased from 77 in the control group to 80 in the intervention group. The average EQ-VAS score also in-

creased to 57.46 ± 10.30 ($P = 0.000$; 95% CI: -12.493 to -6.706) in the control group and 67.06 ± 8.10 ($P = 0.000$; 95% CI: -12.493 to -6.706) in the intervention group, respectively. Based on the statistical tests, this difference was significant. These results indicate that the intervention provided to the intervention group significantly improved the patients' perceived health status (QoL), as specifically captured by the EQ-VAS, compared to the control group.

DISCUSSION

This study integrates a comprehensive IMM ap-



Table 8 EQ-VAS Scores of geriatric congestive heart failure patients.

Time Point	Group	Lowest VAS Score	Highest VAS Score	Mean $\pm$ SD	<i>t</i> (<i>P</i> -value)	95% CI
Pre	Control	30	75	56.81 $\pm$ 10.97	0.829 (0.408)	-2,246–5,497
	Intervention	25	75	55.19 $\pm$ 13.67		
Post	Control	30	77	57.46 $\pm$ 10.30	-6.554 (0.000)	-12,493 to -6,706
	Intervention	50	80	67.06 $\pm$ 8.10		

EQ-VAS (Visual Analogue Scale) represents the patient's self-rated health on a vertical scale from 0 ("The worst health you can imagine") to 100 ("The best health you can imagine"). SD: Standard Deviation. *t* (*P*-value): Results from independent *t*-tests; a *P*-value of < 0.05 is considered statistically significant. The *P* = 0 in the post-test row indicates a highly significant statistical difference between the Control and Intervention groups following the study period.

proach across the continuum of care – admission, inpatient care, and discharge – supported by structured interventions such as STOPP/START reviews, CHF educational videos, and individualized medication lists. Key components of the intervention include medication history taking, therapy review, deprescribing based on the STOPP/START criteria, and patient education, all of which contribute significantly to optimizing medication use and preventing medication-related problems.

Patient medication management in hospitals, especially in older adults or those with chronic diseases, is complex and requires a collaborative interprofessional approach. One of the interventions developed in this study is the IMM model, which is designed to integrate decision-making related to drug therapy among doctors, pharmacists, and nurses in a digital system. IMM was then implemented through the MINE application, which was developed specifically to facilitate the documentation, review, communication, and reporting of patient medications. The results of the first stage of research are the results of expert validation showing that all items have I-CVI $\geq$ 0.86, which indicates that each aspect is relevant to the majority of experts, and the S-CVI value = 0.94 $\geq$ 0.90, which indicates that the IMM model is validated and can be used for the implementation stage.

The characteristics of patients in this study showed that the majority of patients with CHF were male, in line with the literature stating that men are at higher risk of developing heart disease due to low hormonal protection, such as estrogen possessed by women.^[23] Most patients were included in the young elderly category, and there was no statistically significant difference between the intervention and control groups (*P* = 0.203). As age increases, degenerative processes such as decreased myocyte function and vascular fibrosis increase the risk of CHF.^[24] In addition, most patients received $\geq$ 5 drugs during hospitalization, reflecting the phenomenon of polypharmacy, which is common in geriatric patients

with multiple comorbidities.^[25] This pattern is consistent with the characteristics of geriatric patients, who generally have $\geq$ 3 comorbidities. Length of hospitalization was generally in the range of 5–10 days, and there was no significant difference between groups (*P* = 0.633; 95% CI: 0.265–1.836), with improved inpatient outcomes being more common in the intervention group, indicating a positive effect of the intervention in supporting clinical outcomes.^[26]

Potentially Prescribing Omissions were still common, especially in the administration of antiplatelets, statins, ACE-I, and β -blockers. Despite improvements from admission to discharge, some patients did not receive therapy in accordance with the STOPP-2 criteria.^[17] Significant antiplatelet PPOs indicate negligence in the management of patients with vascular disease^[27], whereas statin and ACE-I PPOs have the potential to increase the risk of subsequent cardiovascular events.^[28] A similar finding was observed for β -blocker PPOs, although the PPO rate decreased after the intervention. These findings indicate the need to optimize clinical guideline-based prescribing for geriatric patients with CHF.^[29]

The use of Potentially Inappropriate Medication in geriatric patients with CHF also decreased after the intervention, especially the use of beta-blockers in patients with cardiac conduction disorders, ACE-I/ARB in patients with hyperkalemia, and aspirin without PPI protection. The duration of dual antiplatelet therapy (DAPT) should be individualized according to the patient's bleeding and ischemic risk profiles, supported by validated risk stratification scores, rather than relying solely on a uniform standard duration. The decrease in the prevalence of PIM from admission to discharge indicates awareness and intervention of medication rationalization during care.^[30–32] Comprehensive evaluation and monitoring of therapy in elderly patients with CHF are important to prevent drug side effects and cardiovascular complications that can worsen prognosis.^[33]



This finding is in line with a study by Hellström, *et al.*,^[34] which demonstrated that clinical pharmacist interventions in the care of elderly patients can significantly reduce medication errors, particularly during transitions into and out of hospitals. Similarly, a randomized clinical trial by Lee, *et al.*^[35] showed that pharmacist-led interventions – including comprehensive medication reconciliation and patient education – significantly reduced drug-related problems (DRPs) among geriatric patients with polypharmacy. DRPs were defined as any preventable or potential medication-related issues that could interfere with optimal patient outcomes.

Quality of life assessment using the EQ-5D-5L showed that discharge planning intervention in the form of a medication list increased the utility index score of elderly patients with CHF. The EQ-5D-5L instrument is a comprehensive and internationally validated tool for assessing health-related quality of life, including in geriatric populations. The control group showed a decrease in quality-of-life scores from pre-to post-test, while the intervention group experienced a significant increase, from 0.552 to 0.664. This improvement is driven by specific mechanisms where medication optimization minimizes adverse effects, polypharmacy-related impairments, and symptom burden by reducing inappropriate medications and tailoring therapy to individual patient profiles. This reflects the benefits of discharge planning in supporting patient understanding of therapy, increasing compliance, and reducing the risk of adverse post-hospitalization events.^[22] The maximum utility score reached 1,000 in the intervention group, indicating that some patients achieved optimal QoL after the intervention. Furthermore, the statistical tests revealed significant improvements in specific EQ-5D-5L dimensions, notably Pain/Discomfort and Depression/Anxiety. These findings highlight the direct connection between individualized, guideline-concordant medication management and meaningful improvements in patient-reported outcomes (PROs), including physical functioning, symptom control, and mental well-being. The EQ-VAS results showed a significant increase in the intervention group after discharge planning in the form of a medication list ($P = 0.000$; 95% CI: -12.493 to -6.706), from 55.19 ± 13.67 to 67.06 ± 8.10 . In contrast, the increase in the control group was not significant. This targeted improvement illustrates that the intervention contributes positively to specific aspects of QoL, rather than providing a global QoL improvement. This targeted QoL improvement is highly

probable because the medication optimization process (IMM/STOPP/START) directly targeted DRPs that exacerbate symptoms like fatigue, pain, and anxiety, thereby linking medication optimization to specific patient reported outcomes. This also shows that the provision of a medication list not only has an impact on clinical aspects but also on the patient's subjective perception of their well-being. This intervention has been shown to be effective in improving patient self-management and confidence in receiving long-term care.^[36]

The implementation of IMM improves the quality of life of geriatric patients with CHF through well-defined clinical mechanisms. These include medication reconciliation at admission, therapy review using the STOPP/START criteria to reduce inappropriate medications and optimize guideline-directed regimens, and collaborative monitoring of medication errors, which decreases adverse effects and enhances clinical stability during hospitalization. During the transition-of-care phase, discharge planning supported by a medication list and audiovisual education strengthens continuity of care and enhances patients' self-care capacity, enabling them to take medications correctly, maintain adherence, recognize early signs of deterioration, and reduce anxiety related to disease management. These mechanisms directly contribute to improvements across EQ-5D-5L dimensions – particularly mobility, daily activities, pain/discomfort, and anxiety – reflected in significant differences between the intervention and control groups. These findings align with self-care theory and previous evidence showing that structured discharge planning and clear medication information improve clinical outcomes and quality of life in geriatric patients.^[37–39]

This suggests that IMM is not only effective in reducing the number of patients who experience medication errors but also in reducing the frequency and intensity of errors in each individual patient. This finding is consistent with the research by Gillespie *et al.*, who showed that a comprehensive pharmacist intervention under a structured medication management model significantly reduced drug-related problems and medication errors in elderly patients; the intervention group experienced fewer DRPs compared with control after systematic pharmacist involvement during hospitalization.^[40]

In addition, a systematic review by Mekonnen, *et al.*,^[41] confirmed that the implementation of medication reconciliation and interprofessional collaboration-based ther-



apy reviews can reduce the risk of medication errors by 54%. These findings highlight the critical role of pharmacist in ensuring medication safety and optimizing therapeutic outcomes in older adults, especially during periods of care transition.

The decrease in cases at each stage of the care process shows that a sustainable and integrated approach has a greater impact than a partial intervention. This is in line with the report from WHO (2022) in the “Medication Without Harm” campaign, which emphasizes the importance of systems that prevent errors throughout the care cycle, especially in vulnerable patients, such as the elderly with CHF. Thus, this study supports previous findings that IMM is an effective model for improving the safety of patients. The successful reduction of medication errors through IMM provides a strong basis for the adoption of this model as a standard practice in the medication management of geriatric patients, particularly those with chronic conditions such as heart failure, who are particularly vulnerable to therapeutic errors due to polypharmacy and complex care transitions.

The findings demonstrate that the model significantly enhances medication accuracy, reduces rehospitalization rates, and improves patient quality of life, as measured by EQ-5D-5L VAS scores. Moreover, the results underscore the critical role of active collaboration among physicians, nurses, and pharmacists in therapeutic decision-making and the effective use of digital tools to support team-based clinical practice. The MINE application strengthens collaboration among the attending physician (DPJP), pharmacists, and nursing staff by providing a centralized, real-time platform for shared clinical decision-making. This collaboration is operationalized through a clinically oriented workflow specifically designed to bridge communication gaps during hospital care. Within this framework, pharmacists systematically conduct medication reconciliation at every stage of care by comparing newly prescribed orders against the patient’s pre-admission medication history to prevent discrepancies. Furthermore, the platform facilitates targeted medication reviews; pharmacists utilize the STOPP criteria to identify Potentially Inappropriate Medication (PIM) use, while the START criteria are applied to identify potential therapeutic omissions, ensuring that the treatment plan is optimized for the patient’s clinical condition. Any identified concerns or requirements for therapy continuation are promptly communicated to the DPJP, allowing therapeutic decisions to be finalized

through interprofessional discussion. Additionally, the application incorporates a validated medication error checklist to minimize clinical risks. Therefore, the proposed digital-based IMM model presents an innovative and practical solution for improving the safety and effectiveness of therapy for geriatric patients in hospital settings.

Medicine Management (IMM) model through the MINE (Medicine IN gEriatric) application demonstrated significant benefits for elderly patients with congestive heart failure. Key findings included: (1) reduction in potentially inappropriate medications (PIMs) and potential prescribing omissions (PPOs) from admission to discharge; (2) decrease in medication errors across all stages of hospitalization (admission, inpatient care, discharge); (3) improvement in quality of life scores as measured by EQ-5D-5L and EQ-VAS tools in the intervention group; and (4) reduction in rehospitalization rates for the intervention group compared to the control group.

In conclusion, this study highlights the effectiveness of a technology-enabled multidisciplinary approach to optimize medication management in geriatric patients. The MINE-based IMM intervention successfully enhanced prescribing practices, reduced inappropriate medication use, and improved the patient outcomes. These findings align with current evidence-based clinical guidelines, including the STOPP/START criteria and World Health Organization (WHO) recommendations on medication safety and transitions of care. Our results emphasize that interprofessional medication reviews supported by digital tools, such as the MINE app, may significantly enhance prescribing appropriateness, reduce medication-related problems, and improve overall patient safety in hospital settings. This model presents a promising solution for improving medication safety and efficacy in geriatric care, particularly in patients with complex conditions, such as congestive heart failure. However, the study is limited by its single-center, quasi-experimental, non-randomized design, and small sample size; however, despite these limitations and the short observation period, the robust effect size observed in key outcomes suggests high interpretability and clinical reliability for immediate utility in similar settings. Although the MINE application proved technologically effective, the generalization of current findings is currently restricted to this pilot study site (RSUD Abdoel Wahab Sjahranie Samarinda). Nevertheless, MINE has the potential for broader implementation and scalability across various



healthcare settings, particularly in hospitals with similar accreditation and clinical profiles. Therefore, it is strongly recommended that future research focus on developing a cloud-based, easily adaptable version of MINE and conducting larger, multicenter Randomized Controlled Trials (RCTs) with longer follow-up, specifically extending to 6–12 months to confirm these findings, fully assess rehospitalization rates, and evaluate the intervention's generalizability across diverse clinical settings.

DISCLOSURE

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Conflicts of Interests

None.

Ethics Statement

This study was approved by the Human Research Ethics Committee of RSUD A.W. Sjahranie, Samarinda, Indonesia (No.135/KEPK-AWS/VIII/2022).

Author Contributions

All authors contributed to the conception and design of the study. WDA contributed to data collection, data analysis, and writing the first draft of the manuscript. CG, UA, and EZ supervised the WDA and reviewed and commented on the research and manuscript. EZ finalized the data analysis and manuscript and secured funding for the study. All authors have accepted responsibility for the content of the manuscript and approved its publication.

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REFERENCES

- [1] Zarrinkoub R, Wettermark B, Wändell P, *et al.* The epidemiology of heart failure, based on data for 2.1 million inhabitants in Sweden. *Eur J Heart Fail* 2013; 15: 995–1002.
- [2] Conrad N, Judge A, Tran J, *et al.* Temporal trends and patterns in heart failure incidence: a population-based study of 4 million individuals. *Lancet* 2018; 391: 572–580.
- [3] Dharmarajan K, Rich MW. Epidemiology, pathophysiology, and prognosis of Heart failure in older adults. *Heart Fail Clin* 2017; 13: 417–426.
- [4] Lindmark K, Boman K, Olofsson M, *et al.* Epidemiology of heart failure and trends in diagnostic work-up: a retrospective, population-based cohort study in Sweden. *Clin Epidemiol* 2019; 11: 231–244.
- [5] van Riet EES, Hoes AW, Wagenaar KP, *et al.* Epidemiology of heart failure: the prevalence of heart failure and ventricular dysfunction in older adults over time. A systematic review. *Eur J Heart Fail* 2016; 18: 242–252.
- [6] Ødegaard KM, Hallén J, Lirhus SS, *et al.* Incidence, prevalence, and mortality of heart failure: a nationwide registry study from 2013 to 2016. *ESC Heart Fail* 2020; 7: 1917–1926.
- [7] Molokhia M, Majeed A. Current and future perspectives on the management of polypharmacy. *BMC FAM Pract* 2017; 18: 70.
- [8] Hohl CM, Dankoff J, Colacone A, Afilalo M. Polypharmacy, adverse drug-related events, and potential adverse drug interactions in older patients presenting to an emergency department. *Ann Emerg Med* 2001; 38: 666–671.
- [9] Landi F, Russo A, Liperoti R, *et al.* Anticholinergic drugs and physical function among frail older population. *Clin Pharmacol Ther* 2007; 81: 235–241.
- [10] Lavan AH, Gallagher P. Predicting risk of adverse drug reactions in older adults. *Ther Adv Drug Saf* 2016; 7: 11–22.
- [11] National Institute of Statistics Romania. Health status of the population in Romania. http://www.insse.ro/cms/sites/default/files/com_presa/com_pdf/sanata_te2015r_0.pdf (accessed February 19, 2020).
- [12] Ruiter R, Visser LE, Rodenburg EM, *et al.* Adverse drug reaction – Related hospitalizations in persons aged 55 years and over: a population-based study in the Netherlands. *Drugs Aging* 2012; 29: 225–232.
- [13] Sferrazza G, Nicotera G, Pierimarchi P. Suspected adverse drug reactions (ADRs) trends in older Italian patients: an analysis from the National Pharmacovigilance Network. *Aging Clin Exp Res* 2021; 33: 1683–1687.
- [14] World Health Organization. Global health and ageing, 2011. https://www.who.int/ageing/publications/global_health.pdf (accessed February 19, 2020).
- [15] Miller GE, Sarpong EM, Davidoff AJ, *et al.* Determinants of potentially inappropriate medication use among com-



- munity-dwelling older adults. *Health Serv Res* 2017; 52: 1534–1549.
- [16] Gallagher P, Ryan C, Byrne S, *et al.* STOPP (Screening Tool of Older Person's Prescriptions) and START (Screening Tool to Alert doctors to Right Treatment). Consensus validation. *Int J Clin Pharmacol Ther* 2008; 46: 72–83.
 - [17] Curtin DF, Gallagher P, O'Mahony D. Explicit criteria as clinical tools to minimize inappropriate medication use and its consequences. *Ther Adv Drug Saf* 2019; 10: 1–10.
 - [18] Hill-Taylor B, Sketris I, Hayden J, *et al.* Application of the STOPP/START criteria: a systematic review of the prevalence of potentially inappropriate prescribing in older adults, and evidence of clinical, humanistic and economic impact. *J Clin Pharm Ther* 2013; 38: 360–372.
 - [19] Tommelein E, Mehuys E, Petrovic M, *et al.* Potentially inappropriate prescribing in community-dwelling older people across Europe: a systematic literature review. *Eur J Clin Pharmacol* 2015; 71: 1415–1427.
 - [20] Scullin C, Scott MG, Hogg A, *et al.* An innovative approach to integrated medicines management. *J Eval Clin Pract* 2007; 13: 781–788.
 - [21] Lemeshow S, Hosmer DW, Klar J, Lwanga SK. (1990). Adequacy of sample size in health studies. World Health Organization.
 - [22] Herdman M, Gudex C, Lloyd A, *et al.* Development and preliminary testing of the EQ-5D-5L. *Qual Life Res* 2011; 20: 1727–1736.
 - [23] Iorga A, Cunningham CM, Moazeni S, *et al.* The protective role of estrogen and estrogen receptors in cardiovascular disease and the controversial use of estrogen therapy. *Biol Sex Differ* 2017; 8: 33.
 - [24] Lazzarini V, Mentz RJ, Fiuzat M, *et al.* Heart failure in elderly patients: distinctive features and unresolved issues. *Eur J Heart Fail* 2013; 15: 717–723.
 - [25] Mortazavi SS, Shati M, Keshkar A, *et al.* Defining polypharmacy in the elderly: a systematic review protocol. *BMJ Open* 2016; 6: e010989.
 - [26] Wati L, Fadhilah U, Hastuti ED. (2021). Discharge Against Medical Advice (DAMA). *Menara Medika*, 4(1).
 - [27] Getachew H, Bhagavathula AS, Abebe TB, Belachew SA. Inappropriate prescribing of antithrombotic therapy in Ethiopian elderly population using updated 2015 STOPP/START criteria: a cross-sectional study. *Clin Interv Aging* 2016; 11: 819–827.
 - [28] Page A, Ruscini JM, Riker GI, *et al.* Clinical impact of medication review and deprescribing in older inpatients: a systematic review and meta-analysis. *J Am Geriatr Soc* 2024; 72: 1098–1110.
 - [29] Dipiro JT, Barbara GW, Terry LS, dan Cecily VD. *Pharmacotherapy Handbook* Eight Edition (2015). New York. The McGraw-Hill Companies. Hal. 82–94.
 - [30] O'Mahony D, O'Sullivan D, Byrne S, *et al.* STOPP/START criteria for potentially inappropriate prescribing in older people: version 2. *Age Ageing* 2015; 44: 213–218.
 - [31] American Geriatrics Society Beers Criteria Update Expert Panel. American Geriatrics Society 2023 updated Beers Criteria for potentially inappropriate medication use in older adults. *J Am Geriatr Soc* 2023; 71: 2052–2081.
 - [32] Morin L, Johnell K, Laroche ML, *et al.* The epidemiology of polypharmacy in older adults: register-based prospective cohort study. *Clin Epidemiol* 2018; 10: 289–298.
 - [33] Phan H, Tran T, Le N, *et al.* Impact of pharmacist-initiated educational interventions on improving medication reconciliation practice in geriatric inpatients during hospital admission in Vietnam. *J Clin Pharm Ther*. 2022; 47(1): 113–121.
 - [34] Hellström LM, Bondesson Å, Höglund P, *et al.* Impact of the Lund Integrated Medicines Management (LIMM) model on medication appropriateness and drug-related hospital revisits. *Eur J Clin Pharmacol* 2011; 67: 741–752.
 - [35] Lee S, Yu YM, Han E, *et al.* Effect of pharmacist-led intervention in elderly patients through a comprehensive medication reconciliation: a randomized clinical trial. *Yonsei Med J*. 2023; 64: 336–343.
 - [36] Scott IA, Hilmer SN, Reeve E, *et al.* Reducing inappropriate polypharmacy: the process of deprescribing. *JAMA Internal Medicine* 2015; 175: 827–834.
 - [37] Kessing D, Denollet J, Widdershoven J, Kupper N. Self-care and health-related quality of life in chronic heart failure: A longitudinal analysis. *Eur J Cardiovasc Nurs* 2017; 16: 605–613.
 - [38] Cobley CS, Fisher RJ, Chouliara N, *et al.* A qualitative study exploring patients' and carers' experiences of early supported discharge services after stroke. *Clin Rehabil* 2013; 27: 750–757.
 - [39] Almborg AH, Ulander K, Thulin A, Berg S. Discharge planning of stroke patients: the relatives' perceptions of participation. *J Clin Nurs* 2009; 18: 857–865.
 - [40] Gillespie U, Alassaad A, Henrohn D, *et al.* A comprehensive pharmacist intervention to reduce morbidity in patients 80 years or older: a randomized controlled trial. *Arch Intern Med*. 2009; 169(9): 894–900.
 - [41] Mekonnen AB, McLachlan AJ, Brien JE. Effectiveness of pharmacist-led medication reconciliation programmes on clinical outcomes at hospital transitions: a systematic review and meta-analysis. *BMJ Open* 2016; 6: e010003.

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