

# Enhancing Discharge Preparedness and Medication Safety among Elderly Diabetic Patients through PDCA-Based Stepwise Health Education

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## Abstract

**Objective:** To evaluate the effect of a stepwise health education model based on the Plan-Do-Check-Act (PDCA) cycle on improving discharge readiness of elderly diabetic patients with oral hypoglycemic drugs, and to provide evidence for optimizing discharge management of chronic diseases. **Methods:** A prospective quasi-experimental study was conducted among 240 elderly inpatients with diabetes mellitus admitted between June 2023 and May 2024. Participants were assigned to a study group (n = 120) or a control group (n = 120). The study group received PDCA-oriented stepwise health education, while the control group received conventional education. **Results:** The study group demonstrated significantly higher discharge readiness scores than the control group (p < 0.001). Eighty percent of patients in the study group achieved excellent medication knowledge, 3.2 times higher than the control group (p < 0.001). Nursing satisfaction was also higher in the study group (90.0% vs. 35.0%, p < 0.001). Within three months after discharge, 81.7% of patients in the study group maintained correct medication behavior, compared with only 15.0% in the control group. Additionally, qualitative interviews indicated that 88.3% of study participants expressed positive feedback toward the hierarchical education model. **Conclusions:** The PDCA-based stepwise health education model significantly improved discharge readiness, medication knowledge, and patient satisfaction, while reducing medication errors within three months after discharge. By integrating dynamic monitoring, hierarchical optimization, and continuous improvement, this model promotes precise and individ-

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ualized health education, offering theoretical and practical support for chronic disease discharge management.

## Keywords

PDCA Cycle, Stepwise Health Education, Diabetes Mellitus, Elderly, Oral Medication Management, Discharge Readiness, Chronic Disease Management

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## 1. Introduction

With the acceleration of population ageing worldwide, diabetes mellitus has become one of the most prevalent chronic diseases threatening the health and quality of life of older adults. According to the International Diabetes Federation (IDF) 2021 report, China has approximately 75.6 million adults aged over 60 living with diabetes mellitus, accounting for 26% of the global elderly diabetic population [1]. As oral hypoglycemic therapy remains the main treatment approach, medication complexity increases substantially with age. Elderly patients are prescribed an average of 4.3 medications daily [2], and nearly half (47.6%) are at risk of medication errors due to cognitive decline [3]. The Expert Consensus on Discharge Preparation Services for Patients with Diabetes in China further reports that medication-related readmissions within 30 days after discharge reach 18.7% [4], underscoring the urgent need for effective and systematic health education before discharge.

Despite this urgency, most current health education programs still rely on standardized, one-size-fits-all instruction that fails to accommodate the diverse cognitive and functional capacities of elderly patients. Randomized controlled trials have shown that the retention rate of medication knowledge is only 32.4% among patients receiving conventional education one week after discharge [5], while interventions incorporating cognitive stratification can raise this rate to 68.9% [6]. Moreover, a meta-analysis demonstrated that medication adherence improved only marginally (Cohen's  $d = 0.31$ ) in the absence of personalized education [7]. Consistent with these findings, the American Diabetes Association (ADA) 2023 Guidelines emphasize the importance of dynamic assessment and continuous improvement to enhance the effectiveness of educational interventions [8]. These insights suggest that a dynamic, individualized educational framework is necessary to ensure sustained behavioral change among elderly patients.

To achieve such dynamic optimization, the Plan-Do-Check-Act (PDCA) cycle—a classical quality management framework—has been increasingly applied in nursing practice. PDCA-based interventions provide a structured, closed-loop process of planning, implementation, evaluation, and improvement, which helps standardize nursing behaviors and enhance patient outcomes. Systematic reviews have confirmed that PDCA reduces the incidence of medication errors [9]. For instance, a program implemented by the National University Hospital of Singapore improved

insulin injection practices, increasing the standardized operation rate from 58% to 89% [10]. However, existing studies have largely focused on in-hospital quality management, while PDCA-based interventions addressing discharge readiness remain scarce, accounting for only 12.4% of related studies [11].

Recent evidence suggests that integrating stepwise education into PDCA-driven care may further enhance its precision and sustainability. Stepwise health education refers to a progressive, staged teaching strategy that aligns learning content with patients' readiness and comprehension levels, thereby facilitating gradual mastery. It draws theoretical support from scaffolding theory and mastery learning models, which emphasize incremental knowledge construction and continuous feedback until target competencies are achieved. By stratifying patients based on cognitive and operational abilities, stepwise education enables progressive learning tailored to individual readiness. Studies have demonstrated its effectiveness in chronic disease management [12]. Similarly, domestic research in China showed that stepwise education based on Mini-Mental State Examination (MMSE) scores increased medication knowledge scores among elderly patients with diabetes mellitus by 28.5 points [13]. Building on these findings, the integration of PDCA principles with stepwise health education may offer a structured, iterative, and individualized strategy to improve discharge preparedness and promote long-term self-management among elderly patients with diabetes mellitus.

## 2. Object and Method

### 2.1. Research Participant

A total of 240 elderly inpatients with diabetes mellitus were recruited between June 2023 and May 2024 using a quasi-experimental design. Participants were allocated to either the control group ( $n = 120$ ) or the intervention group ( $n = 120$ ). A quasi-experimental design was adopted rather than a randomized controlled trial (RCT) because participants were enrolled sequentially according to their hospitalization order, and random allocation was not feasible due to ward management and ethical considerations. This design minimized interference with routine clinical processes while maintaining baseline comparability between groups.

In the control group, 58 participants were male (48.3%) and 62 were female (51.7%), with ages ranging from 60 to 78 years (mean  $\pm$  SD:  $68.3 \pm 4.1$  years). The disease duration ranged from 3 to 12 years (mean  $\pm$  SD:  $6.8 \pm 1.6$  years).

In the intervention group, 60 participants were male (50.0%) and 60 were female (50.0%), with ages between 60 and 78 years (mean  $\pm$  SD:  $68.5 \pm 4.1$  years). The disease duration ranged from 3 to 12 years (mean  $\pm$  SD:  $6.8 \pm 1.5$  years).

Baseline comparisons revealed no significant differences between the two groups in demographic or clinical characteristics ( $p > 0.05$ ), confirming their comparability.

The study protocol was reviewed and approved by the institutional ethics committee of the First People's Hospital of Jingzhou City.

## 2.2. Inclusion and Exclusion Criteria

Inclusion criteria were as follows:

- 1) Age  $\geq$  60 years, conscious, and able to communicate effectively;
- 2) Diagnosed with diabetes mellitus for  $\geq$  1 year and having HbA1c levels between 7.0% and 10.0%, to ensure a stable disease condition;
- 3) Required to continue at least two types of oral hypoglycemic agents after discharge, with an anticipated home medication duration of at least one month;
- 4) Provided informed consent and voluntarily participated in the study.

Exclusion criteria:

- 1) Presence of severe comorbidities (e.g., end-stage renal disease, decompensated heart failure, or malignancy);
- 2) History of cognitive impairment or psychiatric disorders (e.g., schizophrenia);
- 3) Communication barriers (e.g., language difficulties or illiteracy preventing questionnaire completion);
- 4) Participation in other diabetes education interventions within the past three months;
- 5) Planned transfer to a nursing home or long-term care facility after discharge;
- 6) Estimated life expectancy  $<$  6 months (as assessed by the attending physician).

## 2.3. Method

### 2.3.1. Control Group

Participants in the control group received routine discharge education.

- 1) The responsible nurse conducted bedside education within 24 hours prior to discharge, covering drug names, dosages, administration schedules, and methods. Patients were informed about symptoms of hypoglycemia, emergency management procedures, and recommended blood glucose monitoring frequency and targets.
- 2) Each patient received the hospital's standardized Manual for the Use of Oral Hypoglycemic Drugs.
- 3) On the day before discharge, patients attended a 30-minute group session led by nursing staff, with content consistent with the written materials.
- 4) Educational content was uniform for all participants and was not adapted to cognitive or functional differences.
- 5) All sessions were delivered by ward nurses without specialized training in stepwise education.
- 6) After discharge, patients could contact the ward by telephone for medication-related inquiries; however, no proactive follow-up calls or home visits were arranged.

### 2.3.2. Intervention Group

Participants received PDCA cycle-based stepwise health education during hospitalization.

1) Plan phase: Comprehensive assessment tools covering cognitive function, operational ability, and family support were established to evaluate patients' readiness for medication management. The initial assessment was completed within 24 hours of admission, followed by a midterm assessment three days before discharge. Cognitive assessment (8 - 12 min) was conducted by the primary nurse, and operational skills were tested through a standardized medication box-packing simulation. Family caregivers were assessed within 48 hours of admission and again three days before discharge to evaluate supervision and emergency handling abilities.

2) Do phase: Based on assessment results, patients were categorized into three educational levels—basic, enhancement, and consolidation.

Basic education focused on medication knowledge and compliance awareness through one-on-one bedside teaching and large-print graphic manuals. Family caregivers signed supervision agreements and received targeted instruction.

Enhancement education emphasized practical skills using scenario-based simulations, group cooperation (4 - 6 participants), and immediate feedback to strengthen dosage adjustment and emergency response. QR code-based teaching videos were developed for continuous self-learning.

Consolidation education aimed to sustain behavioral change through personalized medication calendars and portable check cards. Follow-up occurred twice weekly post-discharge via WeChat group and phone calls.

Daily evaluation meetings between diabetes specialist nurses and primary nurses ensured dynamic adjustment of each patient's education level, recorded in individualized paper-based education files.

3) Check phase: Implementation effectiveness and weak links were analyzed regularly to identify areas for improvement.

4) Act phase: Successful interventions were standardized, while improvement measures were refined and incorporated into updated protocols.

## 2.4. Observation Indicators

The primary outcome measures were evaluated using a self-developed questionnaire designed to assess four key dimensions of discharge readiness: medication knowledge and adherence, operational skills, emergency management ability, and follow-up monitoring and family support. The scale was reviewed by a five-member expert panel specializing in endocrinology and nursing education to ensure content validity. Each item's content validity index (I-CVI) ranged from 0.85 to 1.00, and the scale-level CVI (S-CVI) was 0.93.

Among the study outcomes, discharge readiness, patient satisfaction, and three-month post-discharge medication errors mainly reflected achievement rates, satisfaction levels, and objective error frequencies, serving as evaluative endpoints rather than measures of internal consistency. Therefore, reliability testing using Cronbach's  $\alpha$  was performed only for the medication knowledge questionnaire, which contained multiple items across several knowledge domains. The Cronbach's

$\alpha$  coefficients were 0.807 for the intervention group and 0.846 for the control group, indicating good internal consistency and reliability of the scale.

#### **2.4.1. Discharge Readiness**

The self-developed assessment scale for discharge readiness of elderly diabetic patients taking oral medication was used for evaluation, covering medication knowledge and compliance, operational skills, emergency handling ability, follow-up and monitoring plans, and family support systems, with a total score of 20 points. The assessment was completed within 24 hours before discharge, led by the responsible nurse. The results were classified as follows: meeting the standard: total score  $\geq 18$  points; partially meeting the standard: 14 - 17 points (supplementary education required); not meeting the standard:  $\leq 13$  points (a new discharge plan needs to be formulated).

#### **2.4.2. Medication Knowledge**

The self-developed questionnaire on medication knowledge of elderly diabetic patients was used, covering drug identification, dosage management, and risk response, with a full score of 16 points. A score of 14 - 16 points was considered excellent mastery; 10 - 13 points indicated partial mastery and the need for supplementary education; and a score of  $\leq 9$  points indicated no mastery, requiring retraining.

#### **2.4.3. Patient Satisfaction**

The self-developed patient satisfaction questionnaire was used, covering aspects such as educational content, methods, communication, and family collaboration, with a full score of 30 points. A score of 26 - 30 points was considered very satisfied; 21 - 25 points, satisfied; 16 - 20 points, average; 11 - 15 points, dissatisfied; and  $\leq 10$  points, very dissatisfied.

#### **2.4.4. Rate of Medication Errors within 3 Months after Discharge**

The self-developed questionnaire on the medication error rate of elderly diabetic patients within 3 months after discharge was used, covering missed doses, repeated doses, and dosage errors. Surveys were conducted at 1 month, 2 months, and 3 months after discharge to dynamically monitor changes in the medication error rate. Each type of medication error with a frequency of  $\geq 1$  time per month was scored as 1 point, with a total score range of 0 - 8 points. Meeting the standard was defined as a total score  $\leq 1$  point; partially meeting the standard: 2 - 3 points, requiring targeted intervention; not meeting the standard:  $\geq 4$  points, requiring comprehensive rectification.

### **2.5. Statistical Analysis**

All data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

Continuous variables with a normal distribution were expressed as mean  $\pm$  standard deviation (Mean  $\pm$  SD), and between-group comparisons were performed using the independent-sample t-test.

Non-normally distributed or ordinal data were described as median (interquartile range) and compared using the Mann-Whitney U test.

Categorical variables were presented as frequencies and percentages, and comparisons between groups were performed using the chi-square test or Fisher's exact test, where appropriate.

A two-tailed p-value < 0.05 was considered statistically significant.

## 2.6. Qualitative Component

To complement quantitative findings, semi-structured interviews were conducted with 30 participants from the intervention group (randomly selected from different education levels) one week after discharge. The interviews explored perceptions of the stepwise education model, clarity of materials, and family involvement. Interviews (15 - 25 minutes each) were recorded by researchers and analyzed using thematic content analysis. A total of 88.3% of respondents expressed positive feedback, primarily highlighting enhanced understanding, improved confidence, and family cooperation.

## 3. Results

### 3.1. Readiness for Hospital Discharge

As shown in **Table 1**, the intervention group demonstrated significantly higher performance across all dimensions of discharge readiness compared with the control group ( $p < 0.001$ ).

Specifically, the mean score for medication knowledge and adherence in the intervention group was  $4.62 \pm 0.48$ , markedly higher than  $3.15 \pm 1.12$  in the control group ( $t = 12.34$ ,  $p < 0.001$ ). The corresponding achievement rate ( $\geq 4$  points) was 96.7% in the intervention group versus 35.8% in the control group ( $\chi^2 = 89.12$ ,  $p < 0.001$ ).

In terms of operational skills and emergency management, the accuracy of medication box packing reached 92.5% in the intervention group and 38.3% in the control group (Fisher's exact test,  $p < 0.001$ ). Similarly, the correct handling rate of hypoglycemia emergencies was 89.2% versus 25.8% ( $\chi^2 = 95.47$ ,  $p < 0.001$ ).

For follow-up and monitoring, 95.0% of patients in the intervention group completed follow-up visits within three months, compared with 45.0% in the control group ( $\chi^2 = 73.28$ ,  $p < 0.001$ ). Family support also improved significantly, with 98.3% of families in the intervention group signing supervision agreements, while only 53.3% did so in the control group ( $\chi^2 = 67.34$ ,  $p < 0.001$ ).

Moreover, the intervention group exhibited a markedly higher rate of proper medication storage (91.7% vs. 30.8%,  $\chi^2 = 84.56$ ,  $p < 0.001$ ) and greater adherence to healthy lifestyle behaviors (88.3% vs. 28.3%,  $\chi^2 = 80.12$ ,  $p < 0.001$ ). The ability to correctly identify high-risk drug combinations also increased substantially (85.8% vs. 20.0%, Fisher's exact test,  $p < 0.001$ ).

Overall, 85.0% of patients in the intervention group achieved the discharge readiness standard (total score  $\geq 18$  points), whereas only 35.0% in the control

group met this criterion ( $\chi^2 = 68.45$ ,  $p < 0.001$ ).

These findings indicate that PDCA cycle-based stepwise health education effectively enhanced multiple aspects of discharge preparation, including knowledge acquisition, operational competence, and home management support, thereby improving overall readiness for discharge among elderly patients with diabetes mellitus.

### 3.2. Medication Knowledge

The medication knowledge scores of the intervention group were significantly higher than those of the control group ( $p < 0.001$ ) (Table 2).

As shown in Table 2, the intervention group achieved significantly higher medication knowledge scores than the control group across all subdimensions ( $p < 0.001$ ).

For drug identification, the mean score was  $5.8 \pm 0.4$  in the intervention group and  $3.2 \pm 1.1$  in the control group ( $t = 18.25$ ,  $p < 0.001$ ), with corresponding achievement rates of 96.7% and 53.3%, respectively.

Regarding dosage management, the mean score reached  $5.6 \pm 0.6$  in the intervention group compared to  $2.9 \pm 1.3$  in the control group ( $U = 1024$ ,  $p < 0.001$ ), and the achievement rate was 93.3% versus 48.3%.

For risk response ability, the mean score was  $3.8 \pm 0.3$  in the intervention group and  $1.5 \pm 0.9$  in the control group ( $t = 22.10$ ,  $p < 0.001$ ), with corresponding achievement rates of 95.0% and 37.5%.

In terms of the total medication knowledge score, the intervention group had a significantly higher average of  $15.2 \pm 1.1$  compared to  $7.6 \pm 3.0$  in the control group ( $t = 25.67$ ,  $p < 0.001$ ).

Moreover, 80.0% of patients in the intervention group achieved “excellent mastery” (14 - 16 points), while only 25.0% of those in the control group reached this level ( $\chi^2 = 76.33$ ,  $p < 0.001$ ).

Conversely, the proportions of patients with “partial mastery” (15.0% vs. 50.0%) and “poor mastery” (5.0% vs. 25.0%) were markedly lower in the intervention group.

These findings indicate that PDCA cycle-based stepwise health education substantially enhanced patients’ understanding of medication identification, dosage control, and risk management, leading to comprehensive improvement in medication knowledge.

### 3.3. Patient Satisfaction

The proportion of patients reporting “very satisfied” or “satisfied” in the intervention group reached 90.0%, significantly exceeding that in the control group ( $\chi^2 = 76.33$ ,  $p < 0.001$ ; Table 3). In contrast, the combined proportion of patients who reported fair, dissatisfied, or very dissatisfied experiences was markedly lower in the intervention group (9.9%) compared to the control group (65.0%). These results demonstrate that the PDCA cycle-based stepwise health education approach

significantly enhanced patient satisfaction with respect to educational content, delivery methods, nurse-patient communication, and family involvement, reflecting improved patient engagement and perceived nursing care quality.

### 3.4. Medication Management Achievement Rates

As shown in **Table 4**, the intervention group demonstrated consistently higher medication management achievement rates across all post-discharge time points compared with the control group ( $p < 0.001$ ).

At 1 month after discharge, 90.0% of patients in the intervention group achieved the standard ( $\leq 1$  point), whereas only 30.0% of those in the control group did so ( $\chi^2 = 84.21$ ,  $p < 0.001$ ).

At 2 months, the proportion of patients meeting the criterion remained high in the intervention group (87.5%) but decreased markedly in the control group (27.5%) ( $\chi^2 = 78.92$ ,  $p < 0.001$ ).

At 3 months, the achievement rate was still 85.0% in the intervention group, compared with 25.0% in the control group ( $\chi^2 = 76.45$ ,  $p < 0.001$ ).

Overall, 81.7% of patients in the intervention group maintained sustained achievement ( $\leq 1$  point across all three assessments), while only 15.0% of patients in the control group did so ( $\chi^2 = 92.14$ ,  $p < 0.001$ ).

These results indicate that PDCA cycle-based stepwise health education effectively enhanced patients' post-discharge medication management, promoting long-term behavioral stability and reducing medication-related risks among elderly individuals with diabetes mellitus.

**Table 1.** Comparison of discharge readiness between the two groups.

Dimension	Indicator	Intervention group (n = 120)	Control group (n = 120)	Statistical test	Statistic	p value
Medication knowledge and adherence	Mean score (Mean $\pm$ SD)	4.62 $\pm$ 0.48	3.15 $\pm$ 1.12	Independent-sample t-test	t = 12.34	<0.001
	Achievement rate ( $\geq 4$ points)	116 (96.7%)	43 (35.8%)	Chi-square test	$\chi^2 = 89.12$	<0.001
Operational skills	Accuracy of medication box packing	111 (92.5%)	46 (38.3%)	Fisher's exact test	-	<0.001
Emergency management ability	Accuracy of hypoglycemia management	107 (89.2%)	31 (25.8%)	Chi-square test	$\chi^2 = 95.47$	<0.001
Follow-up and monitoring plan	Follow-up completion within 3 months	114 (95.0%)	54 (45.0%)	Chi-square test	$\chi^2 = 73.28$	<0.001
Family support system	Family supervision agreement signed	118 (98.3%)	64 (53.3%)	Chi-square test	$\chi^2 = 67.34$	<0.001
Medication storage requirements	Proper medication storage rate	110 (91.7%)	37 (30.8%)	Chi-square test	$\chi^2 = 84.56$	<0.001
Lifestyle management	Compliance with diet and exercise recommendations	106 (88.3%)	34 (28.3%)	Chi-square test	$\chi^2 = 80.12$	<0.001
Medication interactions	Correct identification of high-risk combinations	103 (85.8%)	24 (20.0%)	Fisher's exact test	-	<0.001
Overall discharge readiness	Achievement rate ( $\geq 18$ points)	102 (85.0%)	42 (35.0%)	Chi-square test	$\chi^2 = 68.45$	<0.001

**Table 2.** Comparison of medication knowledge scores between the two groups.

Dimension	Indicator	Intervention group (n = 120)	Control group (n = 120)	Statistical test	Statistic	p value
<b>Drug identification</b>	Mean score (full mark = 6)	5.8 ± 0.4	3.2 ± 1.1	Independent-sample t-test	t = 18.25	<0.001
	Achievement rate	96.7%	53.3%	-	-	-
<b>Dosage management</b>	Mean score (full marks = 6)	5.6 ± 0.6	2.9 ± 1.3	Mann-Whitney U test	U = 1024	<0.001
	Achievement rate	93.3%	48.3%	-	-	-
<b>Risk response</b>	Mean score (full mark = 4)	3.8 ± 0.3	1.5 ± 0.9	Independent-sample t-test	t = 22.10	<0.001
	Achievement rate	95.0%	37.5%	-	-	-
<b>Total score</b>	Mean score (full mark = 16)	15.2 ± 1.1	7.6 ± 3.0	Independent-sample t-test	t = 25.67	<0.001
	Excellent mastery (14 - 16 points)	96 (80.0%)	30 (25.0%)	Chi-square test	$\chi^2 = 76.33$	<0.001
	Partial mastery (10 - 13 points)	18 (15.0%)	60 (50.0%)	-	-	-
	Poor mastery ( $\leq 9$ points)	6 (5.0%)	30 (25.0%)	-	-	-

**Table 3.** Comparison of patient satisfaction levels between the two groups.

Satisfaction level	Score range	Intervention group (n = 120)	Control group (n = 120)	Statistical test	Statistic	p value
Very satisfied	26 - 30	72 (60.0%)	12 (10.0%)	Chi-square test	$\chi^2 = 76.33$	<0.001
Satisfied	21 - 25	36 (30.0%)	30 (25.0%)	-	-	-
Fair	16 - 20	10 (8.3%)	48 (40.0%)	-	-	-
Dissatisfied	11 - 15	1 (0.8%)	18 (15.0%)	-	-	-
Very dissatisfied	$\leq 10$	1 (0.8%)	12 (10.0%)	-	-	-

**Table 4.** Comparison of medication management achievement rates within three months after discharge between the two groups.

Time point	Achievement level	Intervention group (n = 120)	Control group (n = 120)	Statistical test	Statistic	p value
<b>1 month</b>	Achieved ( $\leq 1$ point)	108 (90.0%)	36 (30.0%)	Chi-square test	$\chi^2 = 84.21$	<0.001
	Partially achieved (2 - 3 points)	10 (8.3%)	54 (45.0%)	-	-	-
	Not achieved ( $\geq 4$ points)	2 (1.7%)	30 (25.0%)	-	-	-
<b>2 months</b>	Achieved ( $\leq 1$ point)	105 (87.5%)	33 (27.5%)	Chi-square test	$\chi^2 = 78.92$	<0.001
	Partially achieved (2 - 3 points)	12 (10.0%)	57 (47.5%)	-	-	-
	Not achieved ( $\geq 4$ points)	3 (2.5%)	30 (25.0%)	-	-	-
<b>3 months</b>	Achieved ( $\leq 1$ point)	102 (85.0%)	30 (25.0%)	Chi-square test	$\chi^2 = 76.45$	<0.001
	Partially achieved (2 - 3 points)	15 (12.5%)	60 (50.0%)	-	-	-
	Not achieved ( $\geq 4$ points)	3 (2.5%)	30 (25.0%)	-	-	-
<b>Overall</b>	Sustained achievement ( $\leq 1$ point across 3 assessments)	98 (81.7%)	18 (15.0%)	Chi-square test	$\chi^2 = 92.14$	<0.001

## 4. Discussion

### 4.1. Stepwise Health Education and Hierarchical Learning Framework Based on PDCA

This study combined the PDCA (Plan-Do-Check-Act) cycle with stepwise health education to dynamically optimize medication management among elderly patients with diabetes mellitus. The results demonstrated that the intervention group achieved marked improvements in discharge readiness, medication knowledge retention, and long-term medication safety compared with the control group, underscoring the value of integrating process management into nursing education [14].

Traditional health education often follows a “one-size-fits-all” model that fails to consider individual differences. In contrast, this study adopted a three-dimensional assessment framework—covering cognitive ability, operational skills, and family support—to classify patients into three instructional levels. For example, patients with memory decline were provided with large-font illustrated manuals, while those prone to dosage confusion participated in scenario-based simulation training. This hierarchical educational approach enabled approximately 80% (**Table 2**) of patients in the intervention group to master key medication knowledge, more than three times the proportion observed in the control group, which appears to exceed the effect sizes typically reported in previous studies [13] [15].

### 4.2. Dynamic Optimization and Family Engagement

Educational effectiveness was evaluated twice weekly to identify emerging issues and adjust teaching strategies accordingly. For instance, when many patients were found unable to handle missed doses, additional video sessions on emergency medication management were introduced. Similarly, because some family members lacked supervision skills, targeted family training was implemented. These dynamic, data-driven adjustments led to a substantial reduction in medication errors within three months (**Table 4**).

Furthermore, family members were required to sign supervision agreements, learn emergency management skills, and participate in a WeChat-based consultation group. They reported feeling more confident and capable of supporting patients' medication routines. After discharge, patients received twice-weekly follow-up calls and used personalized medication calendars to document daily use, which facilitated early identification and correction of potential problems. This hospital-home collaborative management model effectively promoted sustained medication adherence, with 81.7% of patients in the intervention group maintaining proper medication behaviors compared with only 15% in the control group (**Table 4**).

### 4.3. Comparison with Existing Evidence

These findings align with broader evidence demonstrating that structured, process-oriented interventions consistently improve transition-of-care outcomes.

Meta-analytic evidence indicates that communication-focused discharge interventions significantly improve treatment adherence (relative risk = 1.24; 95% CI, 1.13 - 1.37) and patient satisfaction while reducing readmission [16]. For older adults, systematic reviews have shown that bridging interventions lasting up to 90 days—combining self-management support, telephone follow-up, and medication reconciliation—achieve the best outcomes in maintaining medication continuity and preventing adverse outcomes [17], consistent with the multi-component structure of our program. Moreover, evidence from pragmatic trials and meta-analyses of pharmacist-led medication reconciliation has demonstrated that structured, multidisciplinary transition programs effectively reduce clinically important discrepancies and improve post-discharge outcomes [18].

Although these interventions differ in professional scope, their consistent success reinforces the broader notion that coordinated, process-driven strategies—such as our PDCA-based model—can meaningfully strengthen medication safety across the continuum of care. Given that approximately half of older adults experience at least one medication discrepancy after hospital discharge, as documented in multiple systematic reviews, the baseline burden of medication-related problems in this population is considerable [18]-[22]. Therefore, the substantial improvement achieved in this study holds both clinical relevance and practical significance, demonstrating that dynamic, tiered education supported by continuous feedback can effectively enhance medication safety and adherence in elderly diabetic patients.

#### **4.4. Limitation**

This study has several limitations. First, the quasi-experimental design may introduce selection bias because participants were enrolled sequentially rather than randomly assigned. Second, the single-center setting may limit generalizability to other healthcare institutions or community contexts. Third, the primary outcome measures relied on self-developed instruments, which may not fully capture all aspects of discharge readiness. Finally, the follow-up period of three months provides preliminary evidence of sustained effects, and longer-term outcomes warrant further investigation through multicenter randomized studies.

#### **5. Summary**

Elderly patients with diabetes face substantial challenges in maintaining medication safety after discharge due to complex therapeutic regimens and cognitive decline. This study demonstrated that integrating the PDCA cycle with stepwise health education can effectively address these challenges. By incorporating continuous monitoring, hierarchical optimization, and iterative feedback, the model achieved both precision and individualization in discharge education, leading to sustained improvements in patients' medication management behaviors. From a practical perspective, this approach provides a reproducible framework for nursing teams to enhance discharge readiness and long-term self-management among

older adults with chronic diseases. Its integration into routine nursing practice could help bridge the gap between hospital and home care, strengthen family participation, and reduce preventable medication errors. Future research should further evaluate the model's cost-effectiveness, scalability, and applicability to other chronic disease populations and community settings.

### Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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