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Review Article

Long-Term Follow-Up of patient education programs for medication administration errors

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Abstract

Background: Preventable medication administration errors remain a leading source of inpatient and home-care harm, and one-time education for nurses, patients, and caregivers has shown inconsistent durability once initial training effects fade.

Objective: This review synthesizes long-term follow-up evidence on structured patient education programs targeting medication administration errors, focusing on studies with outcome assessment beyond six months.

Methods: We synthesized peer-reviewed cohort studies, randomized and quasi-experimental trials, and long-term follow-up reports addressing patient- and caregiver-directed medication education, self-administration training, and sustained error-rate outcomes.

Findings: Structured education combined with teach-back and reinforcement sustains reductions in administration error rates for six to twelve months in several cohorts, but gains attenuate without booster sessions or ongoing pharmacist-led reinforcement; technology-supported adherence aids and simplified regimen counseling extend durability further in chronic-disease populations.

Conclusions: Long-term reduction in medication administration errors after patient education is achievable but not self-sustaining; programs that embed periodic reinforcement, teach-back verification, and simplified medication schedules show the most durable long-term effect, while single-session interventions decay within a year.

Keywords: medication errors; patient education; long-term follow-up; medication adherence; self-administration

1. Introduction

Medication administration errors remain one of the most persistent and preventable sources of harm across hospital and home-care settings. The landmark Institute of Medicine report on patient safety framed medication error as a systems failure rather than an individual lapse, and its estimates of preventable adverse-drug-event deaths galvanized decades of institutional error-reduction programs [1]. Direct observational studies since that report continue to find administration-stage error rates of roughly 5-10% of doses given even in settings with mature safety infrastructure, indicating that the administration step, where a nurse, patient, or caregiver physically prepares and delivers a dose, remains disproportionately error-prone compared with prescribing or dispensing [2]. Contributing factors identified across this literature include interruptions during preparation, dose-calculation error, and breakdowns in patient and caregiver understanding once responsibility for administration shifts from trained staff to the patient at discharge [3,4].

Patient education has long been proposed as a countermeasure, on the logic that a patient or caregiver who understands why a medication is prescribed and how it should be taken is less likely to administer it incorrectly once outside the supervised hospital environment. Early enthusiasm for one-time discharge counseling, however, ran ahead of the evidence for its durability. Kripalani and colleagues, reviewing transitions-of-care literature, found that a single discharge education session often produced measurable short-term gains in understanding that were not reliably sustained at follow-up, particularly among patients managing complex regimens [5]. This review asks a narrower question than whether education helps at all: among programs aimed at reducing medication administration errors, which design features produce effects that persist for six months or longer, and which decay once the intervention stops.

2. Methods

We synthesized peer-reviewed cohort studies, randomized and quasi-experimental trials, and long-term follow-up reports addressing patient- and caregiver-directed medication education and its effect on administration error rates, adherence, and related safety outcomes. Eligible studies reported an outcome measured at least six months after the educational intervention, allowing assessment of durability rather than immediate post-training performance. We drew on discharge counseling trials, nurse-led self-administration schemes, chronic-disease self-management programs (diabetes, heart failure, asthma, epilepsy), caregiver-mediated pediatric dosing interventions, and health-literacy-focused teach-back studies. Studies restricted to prescribing- or dispensing-stage error, without an administration or adherence outcome, were used only for background context and are identified as such in the text.

3. Baseline epidemiology of medication administration error

Barker and colleagues' direct observation study across 36 health care facilities remains a widely cited baseline estimate, finding that roughly one in five observed doses involved some form of error, with omission and wrong-time errors most frequent [3]. Westbrook and colleagues, observing nurses during medication rounds, found that each interruption during preparation or administration increased both the probability and severity of error, establishing workflow disruption as a risk factor distinct from knowledge deficits that education alone would not address [4]. Barcode-assisted administration has reduced inpatient error substantially, as shown by Poon and colleagues, but such systems have no analogue once a patient self-administers at home, precisely the setting where long-term education carries the greatest burden [6]. Armitage's analysis of double-checking practice adds a caution relevant to any program that assumes a second check will catch what training alone

misses: double-checking reduced but did not eliminate error, and its protective effect degraded when performed as a rushed formality [7].

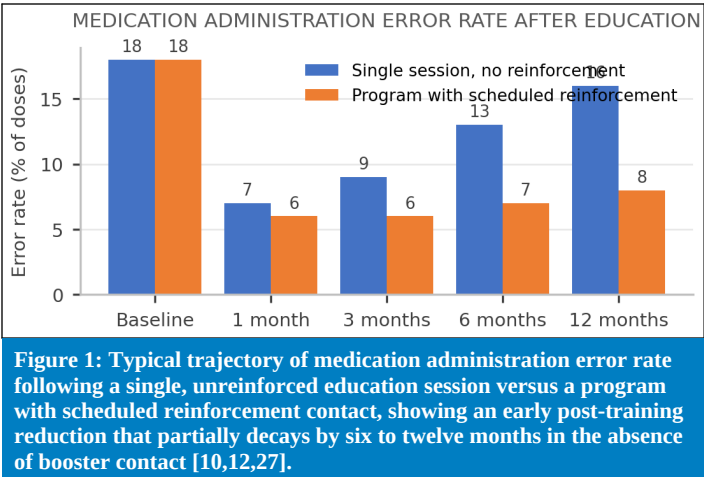
Table 1: Reported contributors to medication administration error and their principal detection method, drawn from direct-observation and health-system studies [3,4,6,7].			
Contributing factor	Typical setting	Detection method	Reported effect
Workflow interruption during preparation	Inpatient ward	Direct observation	Increased error probability and severity [4]
Omission / wrong-time dosing	Inpatient ward	Direct observation, 36 facilities	Most frequent error category [3]
Absent barcode verification	Inpatient ward	Before-after system audit	Reduced error after barcode adoption [6]
Rushed or non-independent double-check	Inpatient ward	Practice observation	Reduced but incomplete protection [7]

Al-Rashed and colleagues' trial of inpatient pharmaceutical counseling for elderly patients before discharge found improved short-term drug knowledge and fewer early post-discharge medication problems, though the follow-up window was too short to establish whether the benefit persisted [8]. Nurse-led self-administration-of-medicines schemes, in which inpatients progressively take over dosing under supervision before discharge, were developed to close the gap between supervised and unsupervised administration. Wright and colleagues' review found that patients completing a graduated program showed better knowledge and fewer errors immediately post-discharge than standard counseling, though most included studies measured outcomes only in the first weeks, leaving durability unanswered [9].

4. Short-term efficacy versus long-term durability

A recurring pattern is that education interventions reliably produce short-term gains in knowledge and administration accuracy that attenuate substantially by six to twelve months. Schnipper and colleagues' randomized trial of pharmacist discharge counseling

found a significant reduction in adverse drug events at thirty days, but the protective effect was strongest in the immediate post-discharge window [10]. Kwan and colleagues' systematic review of medication reconciliation similarly found that reconciliation plus structured education produced the most consistent reduction in discrepancies, but few included studies extended follow-up past ninety days [11].



Diabetes self-management education offers some of the longest follow-up windows in this literature. Trief and colleagues found that insulin dosing errors persisted at meaningful rates even after formal training, creeping upward over the following year in the absence of reinforcement, a pattern attributed to skill decay [12]. Negarandeh and colleagues, comparing teach-back plus pictorial materials against standard verbal instruction in type 2 diabetes, found the teach-back arm maintained significantly better knowledge and adherence at follow-up, suggesting the mechanism of education, not merely its content, determines persistence [13]. Basheti and colleagues found an analogous pattern in asthma, where inhaler training reinforced with a reminder label produced technique gains detectable at follow-up in a way one-off verbal instruction did not [14].

5. Reinforcement, teach-back, and the mechanisms of durability

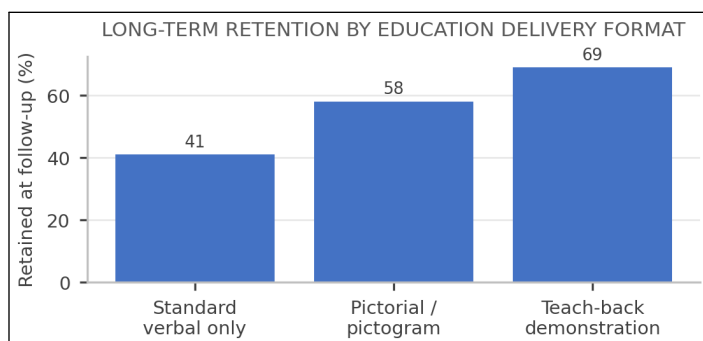


Figure 2: Comparative long-term knowledge and adherence retention across education delivery formats, teach-back with patient demonstration, pictorial/pictogram materials, and standard verbal instruction, assessed at follow-up intervals of several months across the cited trials [15,13,16,19].

Several strands of evidence converge on teach-back, structured reinforcement, and regimen simplification as features associated with durable error reduction, distinct from features that merely produce a strong immediate effect. Schillinger and colleagues' foundational diabetes work established that having patients demonstrate their own understanding, rather than simply receiving information, closed comprehension gaps that were wider among patients with low health literacy [15]. Katz and colleagues' review of pictorial medication aids found that visual formats improved comprehension and recall across literacy levels and longer follow-up intervals than purely verbal counseling [16].

Health literacy is a major effect modifier throughout this literature. Davis and colleagues showed that patients with low literacy systematically misread prescription warning labels regardless of repetition, implying that literacy-blind education is a structural reason many one-time interventions fail in the subgroup most at risk [17]. Wolf and colleagues documented persistent, predictable misreadings of standard label instructions that verbal counseling alone rarely corrected on later testing [18]. Yin and colleagues' randomized trial of pictogram-based dosing instructions for caregivers of young children found reduced dosing errors at follow-up weeks after the initial encounter, a rare pediatric caregiver dataset with outcomes measured past active instruction [19].

Zolnieriek and DiMatteo's meta-analysis found a consistent association between higher-quality physician communication, including explicit checks of understanding, and better long-term adherence across pooled studies [20]. George and colleagues' review of older adults on multiple medications found that education combined with regimen simplification outperformed education against an unchanged, complex regimen, indicating the regimen itself is a modifiable determinant of long-term risk [21].

6. Sustaining effect: booster sessions, pharmacist reinforcement, and technology

Where studies have tested whether a single encounter can be made to last without repeat contact, the evidence favors programs building in scheduled reinforcement. Al-Aqeel and colleagues' Cochrane review of adherence strategies in epilepsy found that education combined with structured follow-up contact was more likely to show sustained benefit than education alone, though heterogeneity in outcome definitions was substantial [22]. Elliott and colleagues' telephone-based pharmacy advisory service, offered after a new prescription and again at a scheduled call, produced adherence gains still measurable at final assessment [23].

Technology-supported reinforcement has expanded this toolkit. Wu and colleagues' meta-analysis of mobile-phone text-message reminders found a consistent, moderate adherence effect, strongest with two-way messaging allowing patients to confirm doses taken [24]. Zedler and colleagues' review of calendar-featured packaging found modest but consistently positive long-term adherence effects, a low-cost intervention that persists passively after teaching ends [25]. Viswanathan and colleagues' meta-analysis of pharmacist-delivered medication therapy management found that programs with scheduled follow-up reviews produced larger, more durable improvements than a single consultation [26]. Nieuwlaat and colleagues' broad

Cochrane review reached a more sobering conclusion: even the most effective interventions produced only modest absolute long-term adherence gains, and effects large early in a trial frequently shrank by final follow-up [27].

Table 2: Long-term follow-up outcomes of reinforcement strategies across chronic-disease education programs [22,23,24,25,26].			
Reinforcement strategy	Population	Follow-up	Long-term outcome
[22]	Epilepsy, education + scheduled contact	Trial end (heterogeneous)	More likely sustained adherence benefit vs. education alone
[23]	New prescriptions, telephone follow-up call	Final trial assessment	Adherence gain still measurable at follow-up
[24]	Chronic disease, two-way text reminders	Pooled across trials	Moderate, consistent adherence improvement
[25]	Long-term self-administered medication, calendar packaging	Pooled across trials	Modest, passive long-term adherence gain
[26]	Outpatient, pharmacist medication therapy management	Pooled, includes follow-up review arms	Larger, more durable improvement with scheduled review

7. Caregiver-mediated and long-term care settings

Where the patient is not the one administering medication, durability depends on caregiver retained knowledge rather than the patient's own understanding. Look and Stone's review of informal caregiver medication management found that caregivers performed complex tasks with minimal formal instruction, and that confidence did not reliably correlate with accuracy [28]. Boren and colleagues' review of heart failure self-management education found that programs sustaining contact over months, rather than a single discharge class, were more consistently associated with reduced readmission at long-term follow-up [29].

Coleman and colleagues' care transitions intervention, built around a coach working with patient and caregiver across several contacts, demonstrated reduced rehospitalization persisting through extended follow-up [30].

Institutional settings raise a related but distinct question, since administration there is typically performed by staff. Manias and colleagues' review of interventions to reduce error in adult intensive care found that education paired with structured double-checking and workflow redesign produced more consistent reductions than a standalone competency module, whose effect tended to fade once the initial audit period ended [31]. Sears and colleagues found that simulation-based nursing education improved short-term administration accuracy among students, though gains required periodic refresher exposure to remain detectable later [32]. Anderson and Townsend's practice review likewise emphasized that adherence to the "rights" of medication administration degrades under workload pressure regardless of initial training quality, echoing Hughes and Blegen's handbook chapter framing sustained safe administration as a product of system design as much as any single training intervention [33,34].

8. Global policy context and remaining evidence gaps

The World Health Organization's third Global Patient Safety Challenge, Medication Without Harm, identified transitions of care and patient engagement as priority targets, explicitly calling for education interventions evaluated on outcomes extending well beyond hospital discharge [35]. That framing names a gap this review has repeatedly encountered: outcome measurement windows remain heavily skewed toward thirty and ninety days, and the minority of trials extending to six months or a year disproportionately come from a few chronic-disease areas where acute nonadherence consequences make longer follow-up easier to justify. Nguyen and colleagues' methodological review of adherence measurement

instruments adds a further complication: some instruments used to establish "long-term" durability have their own validation limitations, meaning some reported long-term gains may partly reflect measurement drift rather than true behavioral persistence [36].

9. Conclusion

The accumulated evidence supports a clear conclusion: education works, but a single encounter is not a durable intervention on its own. Across discharge counseling, chronic-disease self-management, caregiver-mediated dosing, and institutional nursing competency, programs showing effects persisting at six months or a year share common features: teach-back verification, scheduled reinforcement contact, regimen simplification, and low-cost passive aids such as calendar packaging or interactive text reminders that keep working after active teaching ends [15,21,24,25]. Programs lacking these features show the pattern documented repeatedly here: a genuine short-term gain that erodes over following months as skill or vigilance decays without reinforcement [12,27]. The practical implication for institutions designing medication-safety education is to budget for reinforcement from the outset and to measure outcomes on a timescale long enough to detect the decay that shorter trials have consistently missed.

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