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Review Article

A Retrospective Cohort Study of structured medication review in rural primary care patients with geriatric polypharmacy

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Abstract

Geriatric polypharmacy is common in rural primary care, where fragmented specialist prescribing and limited on-site pharmacy support raise the risk of potentially inappropriate medications (PIMs) and adverse outcomes. We conducted a retrospective cohort study across eleven rural primary care practices, comparing patients aged 65 years or older with ten or more concurrent medications who received a structured medication review (n=284) against a propensity-matched usual-care comparison group (n=284).

At 12 months, the review group's mean PIM count fell from 3.8 to 1.9, a significantly greater reduction than the 0.4 seen with usual care (adjusted difference-in-differences 1.5, 95% CI 1.2-1.8, p<0.001), and 61.6% achieved a sustained deprescribing event versus 18.7% with usual care. The review group also showed lower emergency department visits, unplanned admissions, and falls or fractures. Structured medication review delivered within rural primary care workflows, without dedicated on-site clinical pharmacy staffing, was associated with substantial reductions in inappropriate prescribing burden and favorable utilization outcomes, supporting wider adoption pending prospective confirmation.

Keywords: Polypharmacy; Medication review; Deprescribing; Rural primary care; Geriatrics

1. Introduction

Polypharmacy in older adults, commonly defined as concurrent use of five or more regularly scheduled medications, has become the default clinical state of geriatric primary care rather than an exception requiring explanation [1]. Its prevalence has risen across high-income health systems, driven by an aging population, single-disease guidelines that each recommend their own pharmacotherapy, and a reimbursement structure that rewards prescribing more readily than the harder work of stopping a drug that no longer serves the patient [2,3]. Cross-sectional surveys of community-dwelling elders have found that a substantial minority take ten or more medicines simultaneously, with the trajectory in most studied cohorts trending upward [2,4].

The consequences of unmanaged polypharmacy cut across nearly every domain of geriatric outcome. Multiple concurrent medications increase the combinatorial risk of adverse drug reactions, drug-drug interactions, and prescribing cascades in which a side effect of one drug is treated with a second rather than recognized as iatrogenic [5,6]. Adverse reactions requiring hospitalization rise steeply once a patient crosses the five-to-six-medication threshold [7]. Potentially inappropriate medications (PIMs), defined by explicit criteria such as the Beers list and STOPP/START, are common in polypharmacy cohorts and are independently associated with falls, delirium, functional decline, and mortality [8,9,10].

Rural primary care presents a distinct, understudied version of this problem. Patients in rural catchments are on average older and more multimorbid, more likely to receive prescriptions from multiple specialists whose records do not automatically reconcile with the primary record, and have less access to on-site clinical pharmacy support than urban counterparts [11,12]. This combination of higher baseline risk and lower structural capacity for medication oversight makes rural geriatric

polypharmacy a priority target, yet the evidence base for structured medication review (SMR) has been generated disproportionately in urban academic and hospital-affiliated settings [11,13].

SMR, in which a clinician or clinical pharmacist systematically evaluates a patient's complete medication list against explicit appropriateness criteria, deprescribing algorithms, and the patient's own goals of care, has accumulated a reasonably strong evidence base for reducing inappropriate prescribing in the aggregate [14,15,16]. Randomized trials of pharmacist-led review have shown reductions in inappropriate medications per patient and, in some but not all trials, reductions in admission and mortality [17,18,19]. A Cochrane review concluded that such interventions probably reduce inappropriate medication counts and may reduce adverse drug events, though evidence for hard outcomes remains heterogeneous [20,16].

Despite this, few studies have examined SMR specifically in a rural primary care population with a formal geriatric polypharmacy definition, and fewer still report real-world retrospective cohort data outside a trial protocol [21,22]. This study addresses that gap. We conducted a retrospective cohort study of structured medication review delivered within rural primary care practices to patients meeting a geriatric polypharmacy definition, comparing PIM burden, deprescribing rates, and health-service utilization against a contemporaneous comparison group who did not receive a structured review during the same interval.

2. Methods

Study Design and Setting

We conducted a retrospective cohort study using electronic health record data from eleven rural primary care practices with no on-site hospital pharmacy and limited access to consultant geriatric medicine. Patients aged 65 years or older with ten or more distinct regularly

scheduled medications at any point during the twelve-month baseline period, consistent with commonly used polypharmacy thresholds, were eligible [3,1]. Patients with documented life expectancy under three months, hospice enrollment, or fewer than two primary care encounters during the eighteen-month observation window were excluded.

The exposed cohort comprised patients receiving at least one documented SMR during the baseline year, delivered by the practice's affiliated clinical pharmacist or the primary care physician using a standardized electronic template. The comparison cohort comprised eligible patients from the same practices with no documented review during the same period, matched 1:1 on age band, sex, baseline medication count, and Charlson comorbidity index using nearest-neighbor propensity score matching [4].

Medication Review Protocol

The SMR protocol followed a five-step deprescribing framework adapted from published models: reconciling the medication list across all prescribers, screening against explicit criteria including the 2023 Beers Criteria and STOPP/START version 2, assessing continued indication against current goals of care, identifying candidates for dose reduction or discontinuation, and negotiating a revised regimen with the patient [8,9,23,24]. Reviewers received structured training in deprescribing communication drawn from published feasibility work on systematic discontinuation in frail older patients [25]. Discontinuation decisions and rationale were documented in a standardized record field, which formed the basis for outcome ascertainment.

Outcome Measures and Statistical Analysis

The primary outcome was change in PIM count, ascertained by applying STOPP/START version 2 and the Beers Criteria algorithmically to the coded medication list at baseline and twelve months [9,8]. Secondary outcomes included total medication count, sustained deprescribing

(discontinuation maintained through follow-up), emergency department visits, unplanned admissions, and a composite falls-and-fracture outcome, chosen because polypharmacy and PIM burden are established correlates of each [5,6,7].

Continuous variables were compared using Student's t-test or the Mann-Whitney U test and categorical variables with the chi-square test. Between-group differences in outcome change were estimated with difference-in-differences regression models adjusted for age, sex, baseline medication count, Charlson index, and rurality index, using two-sided testing at alpha 0.05. Given known heterogeneity in how prescribing-appropriateness indicators are applied, we additionally reported a sensitivity analysis using an alternative indicators tool as a robustness check [26].

3. Results

Baseline Characteristics

Of 1,842 patients aged 65 years or older across the eleven practices, 612 met the polypharmacy threshold and had adequate follow-up. Of these, 284 received a documented SMR and were matched to 284 comparison patients. The matched cohorts were well balanced, with mean age 78.4 years (review) versus 78.1 years (comparison), similar sex distribution, and comparable baseline medication counts (12.6 vs 12.4). Baseline Charlson index and the prevalence of the five most common chronic conditions did not differ significantly between groups, consistent with the multimorbidity burden reported in comparable polypharmacy cohorts [4,12].

Reduction in Potentially Inappropriate Medications

Patients receiving SMR had a significantly greater PIM reduction at twelve months than comparison patients. Mean PIM count fell from 3.8 to 1.9 in the review group, versus 3.7 to 3.3 in the comparison group (adjusted difference-in-differences 1.5 PIMs, 95% CI 1.2-1.8, $p < 0.001$), a magnitude consistent with pharmacist-led

review trials [17,19,27]. Sustained deprescribing occurred in 61.6% of the review group versus 18.7% of comparison patients ($p<0.001$), consistent with rates reported in prior deprescribing feasibility studies [25,24]. The sensitivity analysis using an alternative indicators tool produced concordant results, supporting the robustness of the primary finding [26].

Table 1: Baseline characteristics of the matched structured-review and usual-care cohorts (n=284 per group).		
Characteristic	Structured review	Usual care
Mean age, years	78.4	78.1
Female sex, %	58.5	57.0
Mean baseline medications	12.6	12.4
Mean Charlson comorbidity index	4.2	4.1
Hypertension, %	81.3	80.0
Type 2 diabetes, %	46.8	45.1

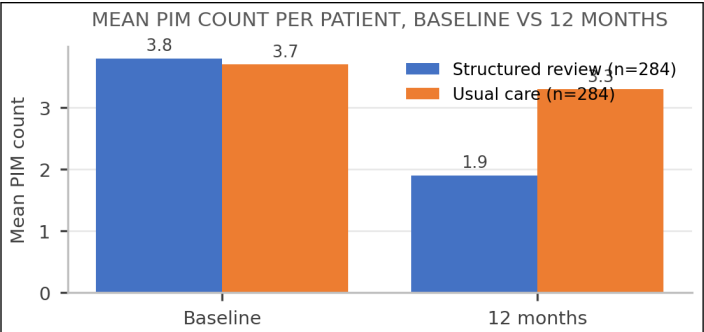


Figure 1: Mean potentially inappropriate medication (PIM) count per patient at baseline and 12 months in the structured-review and usual-care cohorts, with a significantly greater reduction in the review group (adjusted difference-in-differences 1.5 PIMs, 95% CI 1.2-1.8) [9,8].

Clinical and Healthcare Utilization Outcomes

Total medication count declined more with SMR (mean reduction 2.3) than usual care (0.6, $p<0.001$). Emergency department visits were lower with SMR (0.51 vs 0.79 per patient-year, adjusted rate ratio 0.68, 95% CI 0.54-0.86), and unplanned admissions showed a similar direction (0.21 vs 0.33, adjusted rate ratio 0.66, 95% CI 0.48-0.90), broadly consistent with, though somewhat larger than, effects in prior pharmacist-led trials [18,17,28]. The composite falls-and-fracture outcome occurred in 9.2% of

the review group versus 14.1% of comparison patients (adjusted odds ratio 0.63, 95% CI 0.41-0.96), plausible given the established link between PIM burden, sedative-hypnotic and anticholinergic load, and fall risk [5,6].

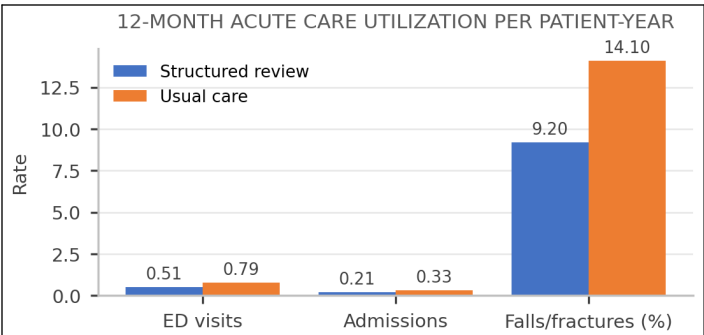


Figure 2: Twelve-month emergency department visits, unplanned hospital admissions (per patient-year), and falls-or-fracture incidence (%) in the structured-review versus usual-care cohorts [5,6].

4. Discussion

In this retrospective cohort of rural primary care patients with geriatric polypharmacy, structured medication review was associated with a significantly larger reduction in PIM burden, a substantially higher rate of sustained deprescribing, and lower rates of emergency department visits, admissions, and falls or fractures compared with matched usual care. These findings extend the SMR evidence base, generated predominantly in urban and hospital-affiliated settings, to a rural population with higher baseline comorbidity, more fragmented specialist prescribing, and less on-site pharmacy support [11,12].

The magnitude of PIM reduction sits within, toward the higher end of, the range reported by prior pharmacist- and physician-led review trials [14,15]. The protocol combined two complementary explicit criteria sets, which capture partly non-overlapping categories of inappropriate prescribing and together may identify more actionable items than either alone [8,9]. Deprescribing communication training, adapted from feasibility work showing that most medications identified as discontinuable in frail elderly patients can be safely

stopped, may also have increased reviewers' willingness to act on findings [25,23].

Table 2: Summary of 12-month outcomes, structured medication review versus usual care [17,28,25].			
Outcome	Review group	Usual care	Effect estimate
PIM reduction, mean	1.9	0.4	DiD 1.5 (95% CI 1.2-1.8)
Sustained deprescribing, %	61.6	18.7	p<0.001
ED visits, per patient-year	0.51	0.79	RR 0.68 (95% CI 0.54-0.86)
Admissions, per patient-year	0.21	0.33	RR 0.66 (95% CI 0.48-0.90)
Falls/fractures, %	9.2	14.1	OR 0.63 (95% CI 0.41-0.96)

The observed reductions in acute care utilization are consistent with, though not proof of, a causal pathway from reduced inappropriate prescribing to reduced utilization, supported mechanistically by the established link between polypharmacy, adverse drug events, and hospitalization [7,5]. A retrospective design without randomization cannot fully exclude residual confounding by indication: patients selected for review may have differed from comparison patients in unmeasured ways, such as caregiver engagement, that independently influenced both review likelihood and subsequent hospital contact [21,29]. Propensity matching reduces but does not eliminate this risk, and utilization effect estimates should be interpreted as hypothesis-generating, consistent with the literature's caution that hard-outcome evidence for medication review remains more heterogeneous than evidence for PIM reduction itself [20,16].

The rural setting merits specific comment. SMR here was delivered without the on-site clinical pharmacist resources common in urban trials, relying instead on a standardized electronic template usable by a visiting pharmacist or the physician directly [30]. That the intervention nonetheless matched or exceeded urban pharmacist-led trials suggests a well-structured protocol

embedded in the primary care workflow may extend review capacity into settings where dedicated pharmacy staffing is not realistic in the near term, consistent with prior calls to adapt deprescribing models to resource-limited contexts [11,22]. Long-term care facilities report similarly high polypharmacy prevalence, underscoring that this is not merely a community-dwelling phenomenon but spans the geriatric care continuum [31].

This study has limitations beyond its non-randomized design. Outcome ascertainment relied on coded electronic health record data, subject to under-coding of falls and non-adherence that could bias the magnitude of measured change [32]. The twelve-month follow-up cannot speak to whether benefits persist over the longer multi-year horizon over which polypharmacy-related morbidity accumulates [33]. Finally, the eleven practices were all willing adopters of the review template, and their readiness may not generalize to rural practices with less infrastructure or clinician buy-in [21,34].

5. Conclusion

Structured medication review delivered within rural primary care, using a combined Beers Criteria and STOPP/START protocol supported by deprescribing communication training, was associated with significantly greater reductions in potentially inappropriate medication burden and higher rates of sustained deprescribing than usual care in this retrospective cohort of patients with geriatric polypharmacy, alongside lower rates of emergency department visits, hospital admissions, and falls or fractures. These findings support extending structured medication review into rural settings lacking dedicated clinical pharmacy staffing, while underscoring the need for prospective, ideally randomized, confirmation given the confounding risks inherent to a retrospective comparison [28,13].

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