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RESEARCH ARTICLE

Impact of a pharmacist-administered deprescribing intervention on nursing home residents: a randomized controlled trial

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Abstract

Background Polypharmacy is prevalent among long-term care residents in Canada, with 48.4% receiving ten or more different medications and 40.7% chronically prescribed potentially inappropriate medications. *Objective* We implemented a pharmacist-administered deprescribing program in a long-term care facility to determine if the number of medications taken per resident could be reduced. Setting: A long-term care facility in Newfoundland and Labrador, Canada from February 2017 to February 2018. Method: Residents were randomized to receive either a deprescribing-focused medication review by a pharmacist or usual care. *Main outcome measure* Change in the number of medications at 3 and 6 months. *Results* Forty-five residents enrolled in the study (n = 22 intervention, n = 23 control). Seventy-eight deprescribing recommendations were made, and 85.1% were successfully implemented. The average number of medications taken by residents in the intervention group was 2.68 less than the control group ($p < 0.02$; 95% CI − 4.284, − 1.071) at 3 months and 2.88 less ($p = 0.02$, 95% CI − 4.543, − 1.112) at 6 months. In 14.9% of cases, a medication had to be restarted after deprescribing was attempted because symptoms returned. Conclusion: A pharmacist-led deprescribing intervention can reduce the number of unnecessary and potentially harmful medications taken by LTC residents.

Keywords Long-term care homes · Canada · Deprescribing · Elderly · Geriatrics · Interprofessional collaboration · Pharmacy services · Polypharmacy

Impacts on practice

- Residents in long-term care facilities in Canada are taking some unnecessary and potentially harmful medications that can successfully be deprescribed.
- Pharmacists can lead deprescribing initiatives in long-term care facility by initiating deprescribing-focused medication reviews and developing plans for implementation.
- A deprescribing plan can be successfully implemented when developed in consultation with residents and their physician, nursing staff and family, where appropriate.

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Introduction

Physiologic and pharmacokinetic changes in older adults increase their risk for drug toxicity, adverse reactions and drug interactions [1]. Certain medications are recognized to be harmful in the elderly and evidence-based guidelines [2, 3] do not support their routine use. Often these medications are started when patients are younger but are not discontinued or reassessed for more appropriate, safer alternatives over time as the patient's health status changes. Additionally, there is a tendency for prescribers to add medications to treat medical issues rather than switch or discontinue therapy that is not working optimally, especially if the medication was originally initiated by another physician [4]. This resultant polypharmacy is associated with increased risk of adverse health outcomes, including preventable emergency room visits, hospitalizations, and mortality [5, 6].

Polypharmacy is prevalent among LTC residents in Canada, with 48.4% of residents receiving 10 or more different medications [1]. Of greater concern is the use of potentially inappropriate medication (PIM), which contribute to

falls, cognitive impairment, hospitalizations and mortality. Among LTC residents, 69.8% received at least one PIM, while 40.7% are chronically prescribed at least one medication from the Beers list of PIMs [1]. Evidence-based algorithms and clinical tools are available to assist health providers in evaluating medication therapies and guiding the process of safe deprescribing, which is the planned tapering, stopping, discontinuing, or withdrawing drugs for the purpose of maintaining or improving health status [2, 3, 7–16]. However, integrating the act of deprescribing into routine prescribing and medication reordering activities is a challenge in practice. Competing priorities, time constraints, lack of focus on deprescribing specifically at the time of medication renewals or ownership of the deprescribing process may be barriers to a sustainable deprescribing program in LTC facilities. Most evidence for deprescribing has targeted specific drug classes, rather than assessing overall appropriateness of medications for the specific individual [17–20]. Integrating a deprescribing focus into medication review activities by pharmacists in LTC may help sustain deprescribing assessments in practice.

Randomized-controlled trials (RCT) have investigated deprescribing interventions in frail older people carried out by physicians [6, 8]. This study aims to assess the effectiveness of a collaborative pharmacist-led deprescribing program in LTC.

Aim of the study

The aim of this study was to develop and implement a pharmacist-administered deprescribing program and assess the impact on reducing the number of medications used by LTC residents.

Ethics approval

This study received ethics approval from The Health Research Ethics Authority of Newfoundland & Labrador (HREB 20171187) and is registered with ClinicalTrials.gov (NCT 03097753).

Method

Study design

Residents of a LTC facility were randomized to receive a deprescribing intervention or usual care in a 1:1 ratio in an open trial with a parallel design.

Setting

The LTC facility, located in St. John's, Newfoundland and Labrador, Canada, is home to approximately 210 residents. This pilot included residents from one floor of the LTC facility which consists of three units, each with 22 residents. Each unit has its own attending physician, all of whom agreed to participate in this project.

Outcomes

The primary outcome of this study was the change in the number of prescribed regular and as-needed (PRN) medications at 3 months and 6 months. Secondary outcomes included changes in patient outcomes such as survival and quality of life.

Recruitment

Enrollment took place from February to August 2017. Residents were informed about the study by their nurse. The research assistant (RA) then contacted the resident (or substitute decision-maker) to obtain consent.

Inclusion and exclusion criteria

Residents were eligible to participate if they were 65 years of age or older and resided on the aforementioned floor at the LTC facility. Residents were excluded if they did not take any regular scheduled medications, were palliative, or if the resident/family/care team declined participation.

Control group

Participants were assigned to the control or intervention group using a computer-generated random number sequence. Participants in the control group continued to receive usual care; medications were reviewed and reordered by the physician on a quarterly basis and the pharmacist completed an annual medication review to assess for drug interactions, dose adjustments, lab monitoring and any modifications to therapy required (i.e. not specifically deprescribing-focused), in addition to pharmacist consultation services as required.

Intervention

As the study took place over a time period when senior pharmacy students were completing their final clinical training, the intervention was performed by pharmacy students under the supervision of pharmacists. Participants in the intervention group received an in-depth medication

review which focused on identifying medications that were no longer required or potentially harmful as opportunities for deprescribing. All recommendations made by students were approved by pharmacists prior to discussing with the medical team and resident.

Using the medication administration record and medical chart a list of all medications, including the dose and frequency, was generated for each participant. A medication-focused clinical history was compiled from the medical chart, including medical history, progress notes, laboratory and diagnostic test results, and by speaking with the participant and family, ward nurse and attending physician. An indication for each medication was determined based on information in the medical chart and through discussion with the physician. Relevant comorbidities, contraindications and possible side effects were documented. Participants were asked whether they still experienced symptoms that were intended targets of specific treatments. Symptom frequency and severity were recorded for any symptoms reported.

A process for deprescribing was developed based on similar studies [8, 15]. Medications were assessed for ongoing need and appropriateness according to the process algorithm depicted in Fig. 1. Appropriateness was assessed according to evidence-based criteria for medication use in the elderly, and those with an unfavorable risk/benefit ratio were recommended for deprescribing [2, 3]. A step-wise approach was taken to making deprescribing recommendations, with medications causing active harm to the participant identified as highest priority (i.e. contraindicated, toxic with no clear indication, or causing severe adverse effects). Medications unlikely to be of benefit or to cause adverse withdrawal effects were addressed next (e.g. multivitamins in those with adequate nutritional intake, aspirin or statins for primary prevention in older adults), followed by medications with a high potential for adverse withdrawal reaction (e.g. benzodiazepines, antihypertensives). Finally, lower risk medications used for symptom relief were considered for deprescribing if symptoms were controlled. Deprescribing recommendations could include discontinuing a medication, reducing the dosage, or switching to a more appropriate medication considering the participant's risk factors and comorbidities. Recommendations also included tapering schedules for medications if an adverse withdrawal reaction or disease recurrence was likely. The pharmacist compiled their assessment into a comprehensive, individualized deprescribing plan for each resident, which specified the cessation order, dose tapering schedule, and monitoring plan. This plan was discussed with the resident, their family (where appropriate) and nursing care team and documented on the resident's chart. The plan was discussed with the physician when they conducted rounds at the facility. When finalized, the deprescribing plan was documented in the resident's chart and implemented over weeks to months, as appropriate. Medications were normally discontinued one at a time; however, the protocol allowed for up to three medications to be withdrawn simultaneously, provided the medications were unlikely to cause adverse withdrawal effects. The pharmacist/pharmacy student counselled the team (physician, resident, family members, and nursing staff) about potential withdrawal or rebound symptoms before deprescribing was attempted, and if the team was not in support of a medication being stopped, cessation was not attempted. The pharmacist/students reviewed participants weekly to oversee and monitor the deprescribing process and were available

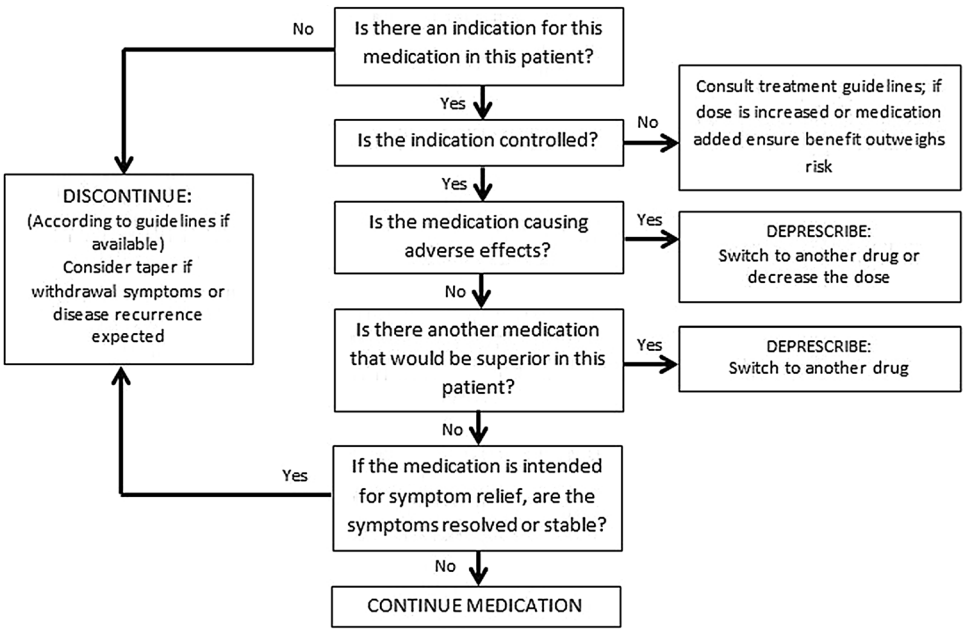

Fig. 1 Intervention—deprescribing algorithm

for support at the LTC facility Monday–Friday. The deprescribing plan could be halted or temporarily interrupted if the participant experienced discomfort or it was felt in the participant's interest to do so. Medications could be added to alleviate withdrawal or symptom recurrence if necessary, or the deprescribed medication may be restarted.

Prior to the launch of the study, nursing and support staff of the LTC facility participated in an education session about deprescribing and polypharmacy in older adults provided by pharmacy students. This session presented evidence and facilitated brainstorming amongst the staff about non-pharmacological strategies to manage behaviours and/or withdrawal symptoms when medications were being deprescribed, and foreseeable challenges were discussed.

Data collection

To assess the primary outcome, the number of prescribed regular and PRN medications was determined by reviewing the resident medication administration record at baseline, 3 months and 6 months post-intervention.

Resident Assessment Instrument (RAI) scales for cognitive performance, depression, pain, social engagement, health status, and activities of daily living were used to assess secondary outcomes. RAI scores are measured as part of the Resident Assessment Instrument Minimum Data Set 2.0 (RAI-MDS 2.0) and routinely collected by LTC staff on a quarterly basis. RAI scores before the intervention were compared to the scores at 3 and 6 months.

Statistical methods

We provided descriptive statistics of means and range to describe baseline characteristics of study participants and used a linear regression model to estimate the difference between control and intervention groups in medication use change at 3- and 6-month follow-ups, together with confidence intervals and p-values. Changes in RAI-MDS 2.0 scores were measured using Repeated Measures ANOVA.

Following guidelines for determining sample size for pilot trials (which suggest a flat rule of at least 30 subjects or greater and a minimum of 12 subjects per treatment arm [21]), our sample size of 45 was within the range recommended by the literature.

Results

Sixty-six residents were eligible to be enrolled; 45 consented to participate (n = 22 intervention, n = 23 control, Fig. 2). Participant demographics are described in Table 1. Over the course of the study seven participants died (n = 4 intervention, n = 3 control); however, no deaths were attributed to the intervention. There was no negative impact on quality of life as reflected by changes in any of the RAI scores from baseline to end of study in either group (data not shown; available upon request).

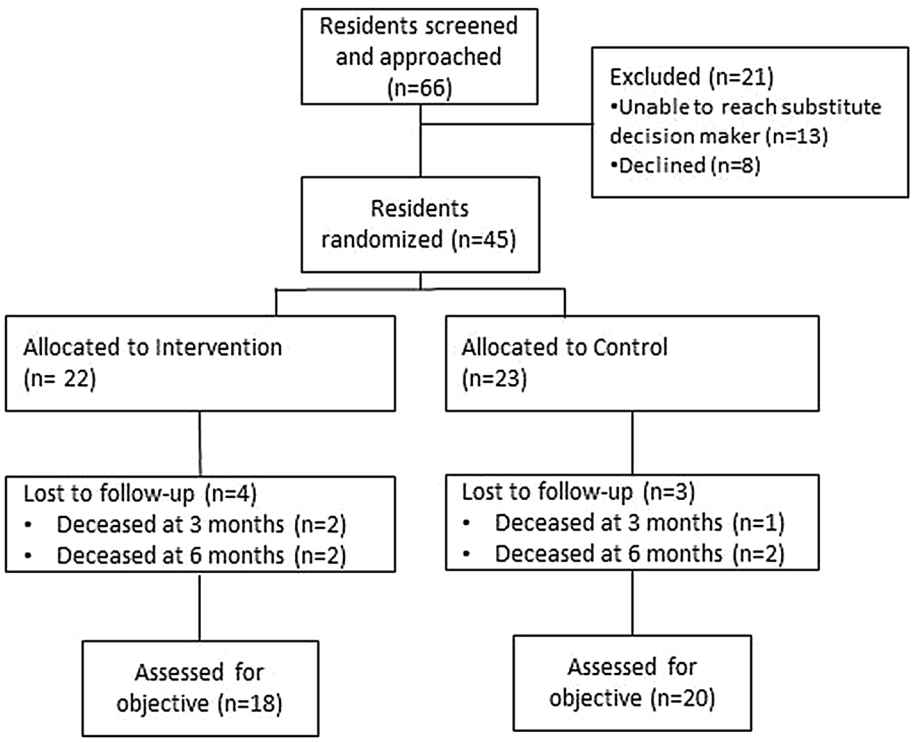

Fig. 2 Participant enrollment and follow-up

Table 1 Baseline characteristics

	Intervention (n = 22)	Control (n = 23)
# Female (%)	10 (45.5%)	13 (56.5%)
Mean age (years) (range)	84.3 (76–97)	84.5 (67–99)
Mean # of medications (range)	14.7 (10–23)	14.5 (7–29)
RAI score		
CPS	n = 22	n = 23
0	4	12
1	6	8
2	2	0
3	2	0
4	2	0
5	3	1
6	2	2
DRS		
0	19	14
1	0	1
2	2	2
3	0	1
4	0	2
8	0	3
PAIN		
0	14	9
1	4	9
2	3	5
ISE		
0	1	0
1	1	0
2	5	9
3	3	2
4	5	2
5	4	7
6	2	3
CHESS		
0	10	18
1	8	5
2	2	0
4	1	0
ADLSF		
0	0	1
2	0	1
3	8	6
4	2	1
5	8	10
6	3	4

CPS Cognitive Performance Score, *DRS* Depression Rating Score, *PAIN* Pain scale, *ISE* Index of Social Engagement, *CHESS* Change in Health and End Stage Disease, Signs and Symptoms, *ADLSF* Activities of Daily Living Short Form

The intervention group experienced a significant reduction in mean number of medications taken per resident at 3 and 6 months. The mean number of medications in the intervention group was 2.68 less than the control group ($p < 0.02$; 95% CI − 4.284, − 1.071, Fig. 3) at 3 months and 2.88 less ($p = 0.02$, 95% CI − 4.543, − 1.112, Fig. 3) at 6 months. Changes in medications included both regularly scheduled and PRN medications. The number of medications successfully deprescribed per resident in the intervention group ranged from 0 to 10.

Deprescribing recommendations included dose reduction, discontinuing medication, or switching to a safer agent. A total of 78 deprescribing recommendations were made; 67 recommendations (85.9%) were accepted and 57 (85.1%) were successfully implemented. Deprescribed medications are outlined in Table 2. Most recommendations reflected a lack of ongoing indication (51, 60%) or dosage was too high (10, 11.8%). Reasons for recommendations not being implemented included concern of worsening symptoms/disease, reluctance to discontinue medication prescribed by a specialist, and patient preference to remain on therapy. In 14.9% of cases, medications were restarted after deprescribing was attempted.

Discussion

Our intervention resulted in 78 recommendations made for 22 residents, indicating there is substantial opportunity to deprescribe medications for LTC residents. Most commonly, deprescribing was recommended because the original indication no longer existed, or the dosage was too high. This highlights the importance of regular medication reassessments as residents' clinical status and medication needs change over time. Residents saw a mean reduction of 2.78 medications without adversely impacting quality of life, suggesting that medications can be safely withdrawn when a collaborative deprescribing plan is implemented.

This pilot study demonstrates how a pharmacist-led, collaborative deprescribing intervention can reduce medication use in LTC. These findings add to existing research supporting the impact that pharmacist-led deprescribing initiatives can have in reducing PIMs in LTC residents [8, 13, 15, 22], providing insight into a Canadian population. A recent meta-analysis of 41 randomized clinical studies showed that deprescribing interventions significantly reduced the number of residents with PIMs, as well as falls and all-cause mortality. They concluded that compared to other deprescribing interventions, medication review-directed deprescribing had significant benefits on older residents in nursing homes [23].

Our deprescribing assessment considered all medications with an aim to reduce any that were no longer indicated or could cause harm. Other studies have focused on

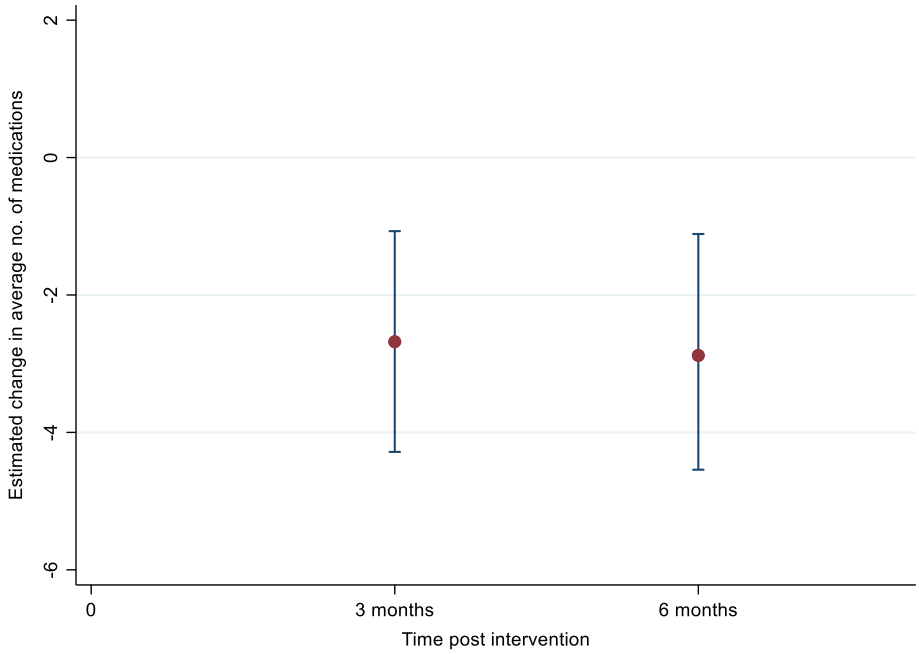

Fig. 3 Between group difference in mean number of medications at 3 months and 6 months

deprescribing specific medication classes in the elderly. The DEFEAT-polypharmacy trial targeted anticholinergic and sedative medications through a pharmacist-led intervention [22]. This study showed similar rates of recommendations and acceptance as well as a similar reduction in medications. Due to their larger sample size, they also found a significant reduction in depression scores and frailty scores at 6 months after deprescribing. Our study was underpowered to detect changes in quality of life scores; however, no concerning trends in RAI-MDS scores were observed. This is consistent with other studies which demonstrate no worsening of function when PIMs are carefully withdrawn from elderly patients [6, 8, 20, 22].

There was a low baseline prevalence of antipsychotic and sedative use in our study, though we did successfully deprescribe these medications in five participants in the intervention group. Targeting medications such as anticholinergics, sedatives, antipsychotic and opioids, which contribute to falls and cognitive impairment is a priority in LTC; however, our comprehensive medication assessment approach identified these as well as additional opportunities to reduce PIMs by taking a holistic approach instead of targeting specific drug classes. Antihypertensives were among the most commonly identified medications for deprescribing in this study. Normally, blood pressure is not routinely monitored in LTC unless there is a concern such as headache or falls. However, by reassessing blood pressure as part of the deprescribing assessment, many residents were found to have hypotension and some reported symptoms of dizziness, falls, or low energy that could be antihypertensive-induced. We also identified examples of "deprescribing cascades" through our comprehensive medication reassessment approach. For example, discontinuing calcium supplements in residents with low fracture risk who were immobile or bedridden often led to improved bowel function and permitted subsequent deprescribing of laxatives and stool softeners as well. The holistic medication review approach may explain why we observed a larger reduction in medication use than some other studies.

The mean number of medications was decreased significantly in the intervention group at 3 months and there was a further decrease in medications at 6 months. This is likely due to the staged deprescribing approach and signifies that the residents who discontinued medications tended to stay off them. We expected there might be a temporary increase in PRN medications in the short term to manage rebound symptoms from deprescribing long-term medications (eg. PRN antacid or H2 antagonist use to manage rebound hyperacidity following discontinuing PPI); however, this was not observed and may be attributed to the staff education to promote non-pharmacologic strategies in support of deprescribing plans and a teamwork approach to providing care.

Physicians were highly accepting of the deprescribing recommendations in this study (85.9% acceptance rate). Reasons for not accepting recommendations were consistent with those cited in literature, including off-label use of a medication, concerns about worsening conditions, patient frailty, patient preference to maintain therapy, specialist prescribing therapy, and a previous unsuccessful trial of deprescribing [22, 24]. Sometimes the decision to deprescribe was complex, considering preferences of patients and prescribers and/or the lack of evidence from practice guidelines, in which case we followed a collaborative consensus-based approach.

Table 2 Details of deprescribing recommendations

Resident	Number of medications suggested for deprescribing	Number of medications accepted to be deprescribed	Number of medications successfully deprescribed	Rationale for deprescribing	Summary	Restarted
1	5	4	4	Fluticasone inhaler: Started many months ago for COPD flare-up which has resolved. Not symptomatic therefore trial a taper to discontinuation Rabeprazole: Long term use for simple GERD not recommended past 12 weeks Mometasone nasal spray: Being used for allergic rhinitis but no longer symptomatic Nitrofurantoin: Taking long-term for UTI prophylaxis, however, recent culture shows resistance to nitrofurantoin. Also, patient's CrCL is 20 mL/min and nitrofurantoin is ineffective in CrCl < 30 mL/min. Switch to Septra® suspension Oxybutynin: Being used for urge incontinence but not effective for this type and significant anticholinergic side effects	Fluticasone (discontinued) Rabeprazole (discontinued) Mometasone (discontinued) Nitrofurantoin (switched) Oxybutynin (rejected due to off label use in patient with recurrent UTI to decrease frequency of infection.)	0
2	5	5	5	Rabeprazole: Long term use not recommended for simple GERD Docusate: No evidence for efficacy in constipation and no symptoms at this time Multivitamin: Eating well, diet suggests supplementation not required Quinapril: Patient is hypotensive and has no other indication for ACE inhibitor therapy Trimethoprim: Switch to Septra® to decrease risk of antibiotic resistant organisms with trimethoprim monotherapy for UTI prophylaxis	Rabeprazole (discontinued) Docusate (discontinued) Multivitamin (discontinued) Quinapril (discontinued) Trimethoprim (switched)	0

Table 2 (continued)

Resident	Number of medications suggested for deprescribing	Number of medications accepted to be deprescribed	Number of medications successfully deprescribed	Rationale for deprescribing	Summary	Restarted
3	5	4	3	Calcium: Patient is bedridden, low fracture risk and experiencing constipation Rabeprazole: long term therapy for simple GERD Acetaminophen: Started for injury months ago and reports no pain at this time Oxybutynin: Reporting urinary incontinence despite therapy and is wearing incontinence products, not necessary and risks outweigh benefits Hydrochlorothiazide: switch to furosemide for pedal edema for increased efficacy	Calcium (discontinued) Rabeprazole (discontinued) Acetaminophen (restarted, patient couldn't tolerate decreased dose) Oxybutynin (discontinued) Hydrochlorothiazide switch (rejected)	1
4	2	1	1	Mometasone nasal spray: Used for allergic rhinitis for many years and allergen not present at LTC facility, no longer required Risperidone: no long-term indication for therapy	Mometasone nasal spray (discontinued) Risperidone (rejected, prescribed by neurologist)	0
5	3	3	3	Amlodipine: patient is hypotensive, reduce dose Rosuvastatin: LDL = 1.07 with only 5 mg, may not be required to keep LDL at target of < 2.0 Donepezil: Unable to perform MMSE which is required for coverage of the medication, and resident has deteriorated since last MMSE of 10. Likely no benefit of therapy and will be expensive	Amlodipine (reduced) Rosuvastatin (discontinued) Donepezil (discontinued)	0
6	2	1	1	Mineral Oil: Risk of aspiration pneumonia; patient in bed most of the time) Hydroxyzine: Highly anticholinergic medication and increased risk with advanced age and declining renal function. Being used for pruritis which has resolved	Mineral Oil (rejected, patient preference to maintain therapy) Hydroxyzine (discontinued)	0

Table 2 (continued)

Resident	Number of medications suggested for deprescribing	Number of medications accepted to be deprescribed	Number of medications successfully deprescribed	Rationale for deprescribing	Summary	Restarted
7	6	5	5	ASA: Patient receiving dual antiplatelet therapy for secondary stroke prevention but long-term therapy not recommended Zopiclone: Using both zopiclone and mirtazapine for sleep. Efficacy is diminished with long term use and adverse effects (falls, cognitive impairment, etc.) outweigh benefit PEG: Patient is interested in stopping therapy, no constipation at this time tolnaftate powder: Fungal infection in skin folds has resolved Cranberry Capsules: Evidence for UTI prophylaxis is lacking and patient is interested in stopping therapy	ASA (discontinued) Zopiclone (discontinued) PEG (discontinued) tolnaftate powder (discontinued) Cranberry Capsules (discontinued)	0
8	4	3	3	Metamucil: Originally started for fecal impaction in hospital which has since resolved and it is not covered by insurance, currently taking sennosides which may be sufficient Mupirocin ointment: Has been prescribed since prior to admission to LTC facility and being applied quite regularly. Should only be used for infection to decrease resistance ferrous fumarate: Patient has been taking iron supplement for many years and last serum ferritin was normal. Hemoglobin is stable. High doses are known to cause GI side effects and she has had fecal impaction recently. Discontinue and reassess ferritin and Hgb in 1 month	Metamucil® (rejected, patient controlled on current bowel regime) Mupirocin ointment (discontinued) ferrous fumarate (discontinued)	0

Table 2 (continued)

Resident	Number of medications suggested for deprescribing	Number of medications accepted to be deprescribed	Number of medications successfully deprescribed	Rationale for deprescribing	Summary	Restarted
9	5	5	3	Estradiol vaginal inserts: Using for UTI prophylaxis but ineffective; evidence for UTI prophylaxis is stronger with antibiotics such as sulfamethoxazole/trimethoprim Pantoprazole: long term PPI not recommended for simple GERD Risedronate: Low risk of fracture in this patient and has been using over 10 years Quetiapine: appears to be being used for insomnia, no hallucinations reported. Use in the elderly associated with multiple risks	Estradiol (switched to sulfamethoxazole/trimethoprim.®) Pantoprazole (restarted, GERD symptoms returned) Risedronate (discontinued) Quetiapine (restarted, experienced hallucinations)	2
10	4	3	3	Metformin: Dose too high for renal function and A1C is well below target < 8.5% Domperidone: Not complaining of any GI symptoms and has other QT prolonging agents on board. Switch to PRN PPI therapy for heartburn symptoms instead to decrease QT risk Vitamin B12: Patient is receiving double the recommended intake through supplementation Enalapril: Patient is complaining of dizziness upon standing which may be due to orthostasis. BP is controlled and doesn't appear hypertensive but may be able to maintain target BP without therapy	Metformin (reduced) Domperidone (switched to PRN rabeprazole) Vitamin B12 (reduced) Enalapril (Rejected, BP controlled)	0
11	3	2	2	Cetirizine: itchy rash has resolved, no longer necessary Docusate: Studies have shown little efficacy for constipation, likely not receiving benefit Eurax cream: patient's itch has resolved, may not require therapy	Cetirizine (rejected, nursing staff note complaining of itching at times) Docusate (discontinued) Eurax Cream (discontinued)	0

Table 2 (continued)

Resident	Number of medications suggested for deprescribing	Number of medications accepted to be deprescribed	Number of medications successfully deprescribed	Rationale for deprescribing	Summary	Restarted
12	4	4	3	Risperidone: Currently taking 3 mg HS, maximum dose recommended for age is 2 mg HS. Guidelines suggest in patients an attempt to taper and withdrawal after 3 months of treatment if symptoms are controlled Citalopram: Carries risk of QT prolongation and currently also taking risperidone. Consider switching citalopram to sertraline as this SSRI has les QT prolongation risk Lorazepam: Prescribed PRN and using once weekly on average. Use is associated with increased risk of falls and cognitive impairment in the elderly. Use non-pharmacological efforts to decrease anxiety/agitation instead Hydrocortisone/nystatin 1:1 cream: Prescribed for previous skin irritation, has since resolved and no longer needed	Risperidone (restarted due to increased anxiety on taper) Citalopram (switched) Lorazepam (discontinued) Hydrocortisone/nystatin 1:1 cream (discontinued)	1
13	1	1	0	Vitamin B12: No deficiency noted through bloodwork investigations	Vitamin B12 (rejected, patient family wanted to maintain therapy)	0
14	4	3	3	Rosuvastatin: over the age of 75 it is recommended to choose lower intensity statin therapy, decrease the dose to 10 mg daily Dimenhydrinate: Prescribed for an episode of nausea a few months ago. Since has resolved Metformin: High dose of metformin may not be required due to decreased appetite. Reassess glucose levels and consider decreasing to the lowest dose required to maintain control of diabetes Rabeprazole: no indication for long-term therapy with PPI	Rosuvastatin (decreased) Dimenhydrinate (discontinued) Metformin (rejected, diabetes targets being currently met) Rabeprazole (discontinued)	0

Table 2 (continued)

Resident	Number of medications suggested for deprescribing	Number of medications accepted to be deprescribed	Number of medications successfully deprescribed	Rationale for deprescribing	Summary	Restarted
15	3	2	2	Rabeprazole: No reflux symptoms at this time, no indication for long-term PPI therapy Sennosides: Complaining of cramping which may be a result of sennosides use, consider decrease the dose to determine if this is a side effect Isosorbide dinitrate: consider switching to isosorbide mononitrate to decrease pill burden as it available in a once a day formulation and will allow for less dosage fluctuations and better control of angina	Rabeprazole (decreased) Sennosides (decreased) Isosorbide dinitrate (rejected, frail and don't want to worsen symptoms)	0
16	4	4	4	Symbicort inhaler: Receiving higher than the recommended maximum dose, consider decreasing to 2 puffs twice daily Simvastatin: less evidence for statin use in elderly (92 years of age) and drug interaction with amlodipine may increase simvastatin level causing increased risk of side effects. Risk may outweigh benefit Rabeprazole: no indication for long-term therapy, no symptoms at this time Melatonin: Sleeping well at this time, no strong evidence for use. Expensive to patient	Symbicort inhaler (decreased) Simvastatin (discontinued) Rabeprazole (discontinued) Melatonin (discontinued)	0
17	4	4	4	Rabeprazole: no indication for long-term therapy and no GERD symptoms at this time Metoprolol: Patient is hypotensive and bradycardic (BP of 108/54 with HR of 48). Currently taking a low dose and no other indication outside of hypertension. No longer required and hypotension increases risk of falls Sennosides: Patient is no longer constipated and is mobile, may not require long-term use Ramipril: If patient remains hypotensive after metoprolol is discontinued, they may not require ramipril either. No other indication outside of hypertension	Rabeprazole (discontinued) Metoprolol (discontinued) Sennosides (discontinued) Ramipril (discontinued)	0

Table 2 (continued)

Resident	Number of medications suggested for deprescribing	Number of medications accepted to be deprescribed	Number of medications successfully deprescribed	Rationale for deprescribing	Summary	Restarted
18	3	2	2	Donepezil: MMSE of 8/30 and no benefit seen from therapy at this level Vitalux®: no diagnosis of macular degeneration and tablet is quite large, complaining of trouble swallowing it due to dysphagia Domperidone: using high dose (50 mg daily) which is above recommended maximum and carries risk of prolongation when used with donepezil and quetiapine. Decrease dose to maximum of 30 mg daily	Donepezil (rejected, family preference to stay on therapy) Vitalux® (discontinued) Domperidone (decreased)	0
19	2	2	2	Diclofenac cream: Patient is not finding this effective Betamethasone/clotrimaderm 1:1 cream: Using regularly for rash which may result in increased side effects and decreased efficacy. Consider changing to PRN only and using a protectant cream such as Ihles Paste® to prevent rash	Diclofenac cream (discontinued) Betamethasone/clotrimaderm cream (discontinued)	0
20	2	2	2	Glyburide: Recommended to avoid in elderly patients due to increased risk of hypoglycemia which can be severe, rapid and prolonged. Consider switching to gliclazide Quetiapine: Use for behavioural symptoms in dementia is not recommend and patient has been on long-term for agitation which is not an issue at this time	Glyburide (switched) Quetiapine (discontinued)	0
21	3	2	2	Ranitidine: No indication for long-term therapy, no symptoms of reflux Lorazepam: Studies suggest possible increase in agitation when benzodiazepines are used in patients with brain injury and may be aggravating anxiety. Decrease the dose slowly to determine effect and discontinue if possible Citalopram: Currently using above the maximum dose for his age group, recommend decreasing the dose to decrease risk of adverse effects and QT prolongation	Ranitidine (discontinued) Lorazepam (decreased) Citalopram (rejected, prescribed by psychiatrist)	0

This study emphasized collaboration and teamwork. The intervention involved a pharmacist-led medication assessment; however, the plan was finalized through consensus with the physician, nursing staff, resident and caregivers as appropriate. This collaborative approach reduced some barriers cited in the literature, including lack of physician time, support or confidence to make deprescribing decisions; lack of awareness of deprescribing opportunities; fear of consequences of deprescribing; and ineffective communication between team members [4, 23]. Furthermore, designating one team member responsible for initiating the deprescribing assessment may support sustainability of a deprescribing program. Understanding the perspectives of residents and their families regarding how best to integrate them into the decision-making process will be important going forward.

The major limitation of this study is our small sample size, which reduced our power to detect differences in quality of life and mortality. Another limitation is the use of RAI-MDS data as a measure of quality of life. RAI-MDS is a useful tool for quality improvement programs and initiatives but evidence for the reliability and validity of these scores remains inconclusive [25]. As these scores were routinely collected by staff prior to this project, we looked for changes in the RAI-MDS scores as a surrogate measure to ensure the intervention was not causing harm. However, change in RAI-MDS scores is not a robust measure and caution should be used when interpreting change.

As the physicians and nursing staff caring for residents in each group were the same and the study was not blinded there could have been a carryover effect from participating in the intervention; however, if anything this would underestimate the effect of the intervention. There were several strengths of this study. The RA who conducted data collection and analysis was blinded to participant allocation to mitigate bias resulting from the open study design. We had no losses to follow up, and introduced a new process within the LTC facility, using resources and processes that were already in place. Although this was a pilot, the RCT design detected a significant difference between groups despite the small sample size.

We demonstrated that a pharmacist-led deprescribing program is effective at decreasing the number of PIMs taken by residents, however, scaling up this program would necessitate more resources to make this standard of care. We relied on pharmacy students to provide medication reviews, as the pharmacist time allocation for clinical services to the LTC facility was insufficient to complete the study in a timely fashion. The significant advantages of a pharmacist-led intervention as compared to a targeted drug class approach including identifying greater deprescribing opportunities using this holistic approach and improved sustainability by granting accountability to a single team member for seeking deprescribing opportunities. An economic evaluation could inform whether increasing pharmacist time to expand this model of care for all LTC residents on a regular basis is worthwhile.

Conclusion

A pharmacist-led deprescribing intervention can reduce the number of unnecessary and potentially harmful medications taken by LTC residents. Further research is warranted to assess the cost-effectiveness of a pharmacist-led deprescribing program in LTC facilities.

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